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SCIENCE BULLETIN
VOL. IV, NO. 1

MAYA DATES AND WHAT THEY REVEAL

A Re-examination of the Evidence in Correlation
Between Central American and
European Time Counts

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Maya Dates and What They Reveal

A Re-examination of the Evidence on Correlation Between Central American and European Time Counts

It is highly desirable that an agreement be reached speedily among scholars on the basic correlation of Maya and European chronology. Not only is the frame work of time relations for all New World history profoundly affected by this correlation in its broader and more general implications but an exact equation which will unite the Maya and Julian day numbers[1] is demanded as the key that alone can unlock the mysteries of ancient science and art in the great civilizations of Central America and Mexico.

We now have an embarrassment of riches in that several correlations are in competition while a single solution is necessary. Some excuse for the unfortunate conflict of opinion is found in the confused record. The evidence at critical points is at once meager and contradictory, containing statements that are irreducible to any logical pattern. One lot of correlations has been formed in the normal way, on double dates which combine the Maya and European calendar systems, these dates mostly occurring in the documents of the sixteenth century. Another lot of correlations has been formed on ideal solutions of the astronomical matter in the ancient inscriptions[2] and in the Dresden Codex.[3]

Most of the older correlations based on the historical materials as well as nearly all the purely astronomical projects of more recent date have either lapsed into innocuous desuetude or openly have been abandoned by their sponsors. Actually the brunt of controversy now strikes on two proposals, each made on interpretations of scattered references from the times of the Spanish Conquest but each reaching out for confirmation in ancient dates. It is clear that many ancient passages on stone and paper, where planetary intervals and accepted hieroglyphs form an astronomical complex, must be explained. But it would be most unwise to demand exact parallelism in mental attitude towards celestial phenomena and the occult categories of astrology for peoples of the Old and New World. One thing is certain: the marvelously accurate time machine of the Mayas can allow no shifts and equivocations. Once the proper equation which will bring about coincidence of Maya days and Julian days is established,

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[1] The Maya day numbers of the Long Count are comparable to the Julian day numbers of Joseph Scaliger, much used by astronomers. The equation called for in a day-for-day correlation is the difference between the numbers applied for identical days.

[2] About 900 dates on the monuments of forty or more Maya cities of the First Empire can be placed in relative order with intervals expressible in days.

[3] The Dresden Codex is the most important of the three surviving Maya books. It can be consulted in a fac-simile published by E. Förstemann in 1880 and 1892. See Bibliography at end of this article.

the time units, great and small, of Maya chronology must be clicked off according to an inexorable law.

Lothrop[1] in a recent article makes this statement regarding the correlation problem as it now stands:

> Many efforts have been made to reduce the ancient Maya dates to European. These attempts have been founded upon the conflicting documentary evidence of the sixteenth century from Yucatan and, in recent years upon astronomical evidence contained in Maya codices and inscriptions. Ultimate elucidation must depend upon the astronomy but any such correlation must pass the barrier of documentary evidence.

The Primary Evidences for Correlation

In the paper that follows I plan to cover as briefly as possible; first, the primary evidences for correlation; second, the lunar statements on the ancient monuments and in the Dresden Codex which have been the main ground of contention; third, all additional records astronomical and otherwise which bear in any important way upon the main problem. I wish this paper to be clear, self-contained and uniformly respectful of the opinions of others.

The Time-Machine of the Mayas. The time-machine pieced together by modern science from the relics of the Maya civilization is an intellectual construction with wheels turning upon wheels, so to speak. The unit time cog engaging all wheels is the day. One set of wheels serves to number days, another set to name them and a third set distributes these numbered and named units over the 365 places of an annual calendar.

The ascending values of Maya numbers are:

Kin	(sun or day)	1 day
Uinal	(from "u" moon)	20 days
Tun	(stone)	360 "
Katun	(20 stone)	72,000 "
Baktun	(400 stone)	144,000 "
Pictun	(8000 stone)	2,880,000 "

The count may go higher. Effectively the second value has the number of days in a month of the annual calendar and the third value has the number of days in 18 months, differing, therefore, from a calendar year only by the amount of the five epagomenal days. All other values except that of the third place are multiples of 20, and etymologically the time units above the tun form a new vigesimal count of tuns. But this should not lead us to believe that the Mayas were counting anything but days. These numbers are written by place-value notation through the device of dot-and-bar numerals as the digits in each place, the dots being 1's and the

[1] Lothrop, S. K., 1928.

bars 5's, so that 2 dots in front of 3 bars are 17. In addition, there is a special sign for zero, this being a full zero rather than an empty zero.[1]

The artistic motive in Maya notation may have led to the invention of the devices called period glyphs which reinforce, as it were, the ordinary concept of place values. But from this invention came the possibility of recording round numbers in abbreviated fashions.

Fig. 1. The Maya Day Signs and, below, the manner of writing them with numerical coefficients for the tzolkin cycle.

Two wheels turning upon each other produce the designations of the days; one which is marked with the numbers 1 to 13 revolves upon another marked with 20 names so that composite designations, 1 Imix, 2 Ik, etc. are produced in a permutation of 13 x 20=260 days: see Table I. This is the famous *tzolkin* of the Mayas and the *tonalamatl* of the Aztecs. The 20 names are written with hieroglyphs (Figure 1) and the coefficients with dot-and-bar numerals.

A third set of ideal wheels distributes the counted and named days over the pattern of a vague year constructed with 18 months of 20 days each plus a short period of 5 days. The first position in each month is recorded

[1] I have explained this concept at some length. See Spinden, 1924, pp. 18-22.

TABLE I

THE MAYA TZOLKIN

	1	2	3	4	5	6	7	8	9	10	11	12	13
Imix	1	8	2	9	3	10	4	11	5	12	6	13	7
Ik	2	9	3	10	4	11	5	12	6	13	7	1	8
Akbal	3	10	4	11	5	12	6	13	7	1	8	2	9
Kan	4	11	5	12	6	13	7	1	8	2	9	3	10
Chicchan	5	12	6	13	7	1	8	2	9	3	10	4	11
Cimi	6	13	7	1	8	2	9	3	10	4	11	5	12
Manik	7	1	8	2	9	3	10	4	11	5	12	6	13
Lamat	8	2	9	3	10	4	11	5	12	6	13	7	1
Muluc	9	3	10	4	11	5	12	6	13	7	1	8	2
Oc	10	4	11	5	12	6	13	7	1	8	2	9	3
Chuen	11	5	12	6	13	7	1	8	2	9	3	10	4
Eb	12	6	13	7	1	8	2	9	3	10	4	11	5
Ben	13	7	1	8	2	9	3	10	4	11	5	12	6
Ix	1	8	2	9	3	10	4	11	5	12	6	13	7
Men	2	9	3	10	4	11	5	12	6	13	7	1	8
Cib	3	10	4	11	5	12	6	13	7	1	8	2	9
Caban	4	11	5	12	6	13	7	1	8	2	9	3	10
Eznab	5	12	6	13	7	1	8	2	9	3	10	4	11
Cauac	6	13	7	1	8	2	9	3	10	4	11	5	12
Ahau	7	1	8	2	9	3	10	4	11	5	12	6	13

with zero and the others with numerals which run from 1 to 19. The month signs are shown in Figure 2. This is a vague year like that of the

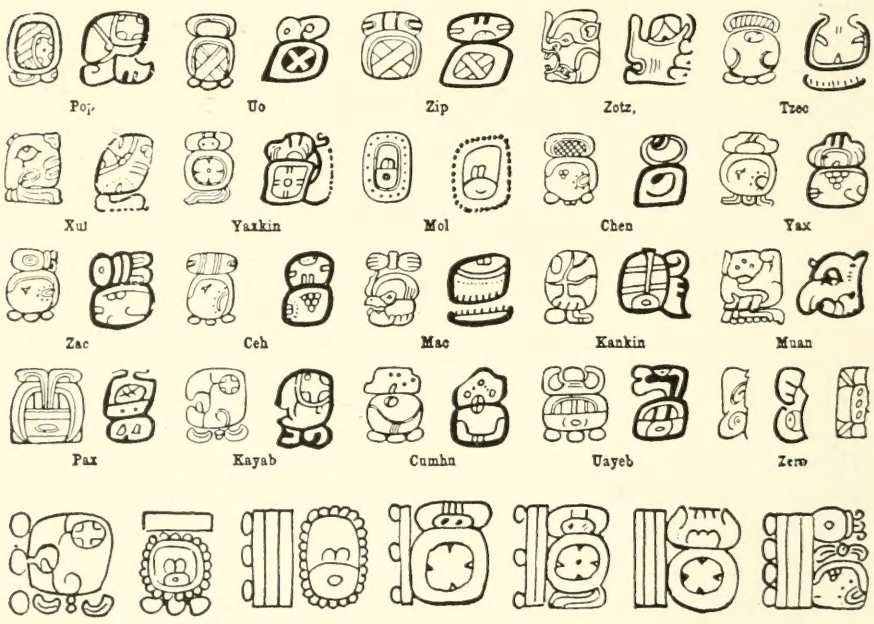

Fig. 2. The Maya Month Signs and, below, the manner of writing them with numerical coefficients to indicate places in the months.

Egyptians uncorrected by intercalation. In combination with the tzolkin the year positions cover what is known as the calendar round of 52x365= 18980 days. In combination with the numeration other over-cycles are produced all of which are expressible in definite numbers of the day as a fundamental time unit.

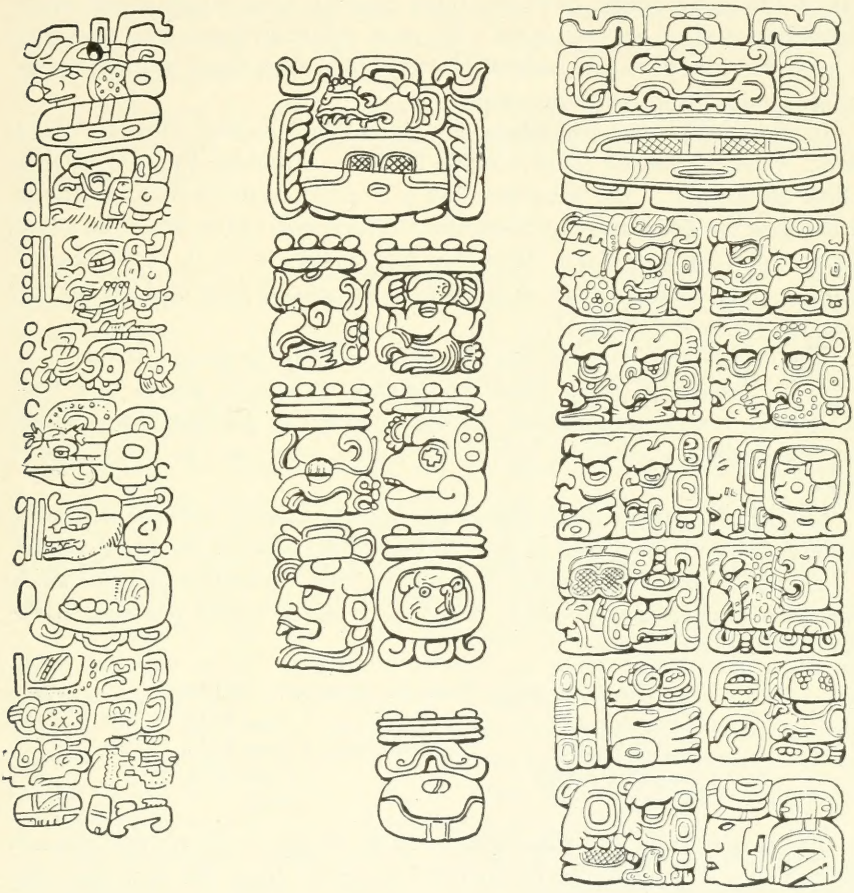

Fig. 3. Initial Series giving complete Maya Dates. The head in the center of the top glyph is the title. In these inscriptions from the Leyden Plate, Stela A of Copan and Stela F of Quirigua, the subject is Venus .

The Mayas, against this background of numbers, designations of the tzolkin and places in the year, which are usually called month-positions, ran off other patterns formed on such astronomical intervals as lunations, eclipse seasons, mean synodical revolutions of Venus, Mars and other planets. These are described as special calendars. The fundamental idea in all these arrangements was to reach ephemerides of the perpetual type,

to borrow the antithetical phrase of a French astronomer. Actually, it was not possible, even for the Mayas, to construct inflexible conditions in the heavens. But we are justified by the evidence in believing that the makers of the Maya time machine were unutterably opposed to backing and filling, or in other words to intercalations and excisions. So far as we may observe they went no further than to use temporary "regents" in this or that uncorrected calendar, these regents being stages which were themselves part of an over-cycle. By such collateral bases they managed to keep the true places of natural phenomena well in hand without sacrificing continuity in their time count.

In Figure 3 several inscriptions are given which present complete Maya dates. In each case the count is made from the Mundane Era and reaches a final declaration. The Mundane Era is 4 Ahau, in the tzolkin, 8 Cumhu in the year or *haab* and has a number written with 13 in the fifth place value. We transcribe this Mundane Era as 13- 0- 0- 0- 0, 4 Ahau 8 Cumhu. The number must be regarded as a special kind of zero for the next baktun is not 14 but 1.

The abbreviated dates of the Mayas are of three principal kinds:

a. Period ending dates which are tzolkin statements placed in a year and joined with a period glyph having a numerical coefficient and which are practically as effective for chronological purposes as Long Count dates.

b. Calendar round dates which are merely tzolkin statements placed in the year; and which run at intervals of 18980 days in the Long Count.

c. Tzolkin statements alone, which have little chronological value since they come back every 260 days. Records of Maya month positions without days are not usual.

THE SAME MAYA DATE BY DIFFERENT METHODS

Long Count	9–13– 0– 0– 0, 8 Ahau 8 Uo
Period Ending	Thirteen katuns, 8 Ahau 8 Uo
Calendar Round	8 Ahau 8 Uo
Tzolkin	8 Ahau

The system explained above applies to the Mayas in the heyday of their civilization. The difficulty of correlation comes from the fact that this civilization, already eclipsed by civil war, was swept away by the Spaniards. The seeds of ancient learning conserved in books were burned upon the scaffolds of the Inquisition and the native priesthood persecuted as devil worshippers.

Interrelations of Ancient and Modern Maya Records. The Maya Chronicles are the merest digests as regards historical content but they are cast in a chronological mould. Events in them are referred to katuns and sometimes to tuns. The conclusion is irresistible that these time periods are really round numbers clicked off by the ancient time-machine, in an unbroken succession out of the golden past. This belief is strengthened

by the great scope of these digests which, for all their meager comment, cover more than fourteen centuries before the coming of the Spaniards.

Indeed, these tuns and katuns of the Maya Chronicles are now generally believed to be:

a. 360 and 7200 days in length, respectively.

b. Round numbers of the third and fourth degrees of value, respectively, in a count of elapsed days running in a modified vigesimal system from a normal date, 4 Ahau 8 Cumhu, which is the common zero for Maya chronological statements.

c. Designated by the day Ahau with which they terminate, this day Ahau in the case of katuns having coefficients which recede by twos, namely in the order:

8, 6, 4, 2, 13, 11, 9, 7, 5, 3, 1, 12, 10, etc.

d. Comparable to ancient period-endings but with the number of the period and its month position suppressed. To revert to the previous example 9-13- 0- 0- 0, 8 Ahau 8 Uo, where the period-ending abbreviation reads 13 katuns, 8 Ahau 8 Uo, the same date in the *u kahlay katunob* system of the Chronicles becomes Katun 8 Ahau. The cycle now covers $13 \times 7200 = 93600$ days or something over 256 years.

In several documents besides the Chronicles events in the sixteenth and seventeenth centuries are stated to fall in certain katuns, the idea being that the events took place within 7200-day periods named by their terminal days. Before taking up these statements, several other chronological matters must be laid before the reader.

The Mayas at the time of the Conquest also were accustomed to fix events in years of 365 days each, these years being called by the name of their beginning day, a system oddly at variance with that of tuns and katuns. The days, Kan, Muluc, Ix and Cauac are *cutz haab* or year bearers. They are placed in the month position 1 Pop although in the ancient usage this becomes 2 Pop.[1] With their appropriate numerical coefficients the year-bearers produce a cycle of 52 years.

This year-bearer system ties in with the katun system in that days of the tzolkin are a common element. The year-bearer itself is a tzolkin statement in a known but generally unexpressed month position, namely 2 Pop. There is abundant evidence of the correspondence between Maya years and Christian years without important conflict in original authorities. For purposes of reference a full round of the year-bearer cycle is

[1] The apparent shift of one day in the possible month position of the days in the tzolkin cycle has been much commented upon but really it is unimportant. In ancient times Ahau, for instance, could be found in the month positions marked by the numerals 3, 8, 13 and 18, while at the coming of the Spaniards it occupied the positions designated by 2, 7, 12 and 17. It is pretty certain, however, that dates can be converted from one system to the other by keeping the tzolkin statement unchanged and shifting the month position by one place. The few dates in the late method are nearly all post-Spanish. On the rings of the Ball Court at Uxmal it may be the intention to declare that 10 Ix 17 Pop and 10 Ix 16 Pop are the same day. On page 66 of the Chronicle of Oxkutzcab a series of tun-endings are recorded and when the shift of one day is applied to the month positions to resolve the ancient alignment the tun endings actually emerge as round numbers of a possible historical location.

given herewith. Other occurrences of the year names can be found by adding or subtracting 52 years or a multiple from the places given here.

TABLE II

THE ROUND OF MAYA YEAR-BEARERS

1 Kan	1529–30	Muluc	1542–43	Ix	1555–56	Cauac	1568–69
2 Muluc	1530–31	Ix	1543–44	Cauac	1556–57	Kan	1569–70
3 Ix	1531–32	Cauac	1544–45	Kan	1557–58	Muluc	1570–71
4 Cauac	1532–33	Kan	1545–46	Muluc	1558–59	Ix	1571–72
5 Kan	1533–34	Muluc	1546–47	Ix	1559–60	Cauac	1572–73
6 Muluc	1534–35	Ix	1547–48	Cauac	1560–61	Kan	1573–74
7 Ix	1535–36	Cauac	1548–49	Kan	1561–62	Muluc	1574–75
8 Cauac	1536–37	Kan	1549–50	Muluc	1562–63	Ix	1575–76
9 Kan	1537–38	Muluc	1550–51	Ix	1563–64	Cauac	1576–77
10 Muluc	1538–39	Ix	1551–52	Cauac	1564–65	Kan	1577–78
11 Ix	1539–40	Cauac	1552–53	Kan	1565–66	Muluc	1578–79
12 Cauac	1540–41	Kan	1553–54	Muluc	1566–67	Ix	1579–80
13 Kan	1541–42	Muluc	1554–55	Ix	1567–68	Cauac	1580–81

The interrelations of the u kahlay katunob, or katun cycle of the Maya Chronicles, and the year-bearer cycle cannot be reduced to a repeating coincidence within usable limits. Thirteen katuns and five calendar rounds open up a gap of 1300 days, thus:

13 x 7200 days = 93600 days
5 x 18980 " = 94900 "

This 1300 day difference between proximate multiples is a most important factor in the problem of adjusting the Maya dates of the sixteenth century to their proper positions in the Long Count.

One statement, collected by Pio Perez in the first half of the last century from a document now lost, does link the u kahlay katunob, or cycle of the katuns, with the round of 52 year-bearers. The day Ahau which gives its name to the katun, and which is really the terminal day of a 7200 day period, is declared in this statement to be the second day of a Cauac year. This can only mean that the Ahau in question fell on 3 Pop, a condition possible, in connection with katuns, only at intervals of $73 \times 7200 = 525600$ days.[1]

On this specific information the following identification in the Maya Long Count of the last katun to be celebrated by the pagan Mayas is made:

Katun 2 Ahau = 12- 8- 0- 0- 0, 2 Ahau 3 Pop.

Here the katun-ending day precisely fulfills the rare condition of coming immediately after a 1 Cauac year-bearer,[2] corresponding to 1516-17 in the Christian Era. The identification is inherently probable and has been

[1] Pio Perez worked out a katun 24 years in length so that every katun could fall on the second day of a Cauac year. No such period was used.

[2] The next earlier case is 8-15- 0- 0- 0, 5 Ahau 3 Pop, when the first Maya dates were being recorded on monuments at Uaxactun.

reached by another and entirely different method which is due for consideration in another place. The exact day in our calendar when this katun ending occurred need not concern us at this point in our investigation.

The nearest other identifications of 2 Ahau as a katun ending (but not, of course, as 3 Pop too) are found 13 katuns on either side of the position noted above or at:

11-15- 0- 0- 0, 2 Ahau 8 Zac and 13- 1- 0- 0- 0, 2 Ahau 3 Chen. These are not as probable as the first position on 2 Ahau 3 Pop but both have been used in correlations. A restatement shows A as the best arrangement, B as a secondary possibility that would shorten the age of the ancient inscriptions over A by 260 tuns while C would lengthen the age by a like amount.

B. Katun 2 Ahau, 11–15– 0– 0– 0, 2 Ahau 8 Zac, Year 4 Ix (1519–20)
A. Katun 2 Ahau, 12– 8– 0– 0– 0, 2 Ahau 3 Pop, Year 1 Cauac (1516–17)
C. Katun 2 Ahau, 13– 1– 0– 0– 0, 2 Ahau 3 Chen, Year 10 Cauac (1512–13)

When we carry these three tentative bases for the correlation of the Long Count, the u kahlay katunob, the Maya year-bearer cycle and the corresponding years of the Christian Era forward 1 katun, we get:

B. Katun 13 Ahau, 11–16– 0– 0– 0, 13 Ahau 8 Xul, Year 11 Ix (1539–40)
A. Katun 13 Ahau, 12– 9– 0– 0– 0, 13 Ahau 8 Kankin, Year 7 Ix (1536–37)
C. Katun 13 Ahau, 13– 2– 0– 0– 0, 13 Ahau 3 Zotz, Year 4 Cauac (1532–33)

Actually, the proofs derived from historical references develop in series from each of these bases. That is, all evidence in agreement with A must conform to the years in the middle column in Table III, and in close cases to certain places in these years.

TABLE III

MAYA KATUNS AND THE YEARS IN WHICH THEY ENDED ACCORDING TO THREE BASIC CORRELATIONS

	B	A	C
Katun 2 Ahau	1520	1516	1513
Katun 13 Ahau	1539	1536	1532
Katun 11 Ahau	1559	1556	1552
Katun 9 Ahau	1579	1575	1572
Katun 7 Ahau	1598	1595	1591
Katun 5 Ahau	1618	1615	1611
Katun 3 Ahau	1638	1634	1631
Katun 1 Ahau	1658	1654	1650
Katun 12 Ahau	1677	1674	1670
Katun 10 Ahau	1697	1694	1690

Evidence Regarding Katun-Endings in the Sixteenth Century. We now pass to a consideration of statements by which katuns and Christian years can be related. We take up the evidence beginning with the Katun

2 Ahau in which the first contacts were established between the Mayas and the Spaniards.

Katun 2 Ahau, B=1520, A=1516, C=1513.

In the Maya Chronicles, proper, Katun 2 Ahau is signalized by the first appearance of the Spaniards and by the outbreak of smallpox, which amounts to about the same thing, since this disease was unknown in ancient America. It may have been brought to Yucatan by Valdivia and his shipwrecked sailors of 1511 or it may have been spread by refugees from the region of the Isthmus. Cordova coasted Yucatan early in 1517 after the close of Katun 2 Ahau in A and C but in the previous year slave raiders had already attacked the Bay Islands at no great distance from Maya territory and carried off to Cuba a large part of the population. From this contact, smallpox might have been introduced within the limits of a Katun 2 Ahau ending in 1516.

In Chronicle II there is a reduplication of a round of katuns and under the first entry of the Katun 2 Ahau now being considered we read:

> On the thirteenth tun foreigners passed, they say for the first time, to this land, the province Yucatan: four score years and thirteen.

The intention is probably to give the 13th tun after the close of Katun 2 Ahau because 7 tuns before the close disagrees with all three provisional bases.[1] But 13 tuns after the close would give 1529 according to arrangement A and might refer to the first campaign of Montejo for the conquest of Yucatan. The "four score years and thirteen" probably states the interval between the destruction of Mayapan and the beginning of warfare with the Spaniards which also agrees with the 1529 position.

The termination of a katun (presumably Katun 2 Ahau) is definitely placed by Nakuk Pech and Macan Pech in 1517, but in an original document upon which their account is based it may have been in a year 1 Cauac which corresponded to 1516-17. Cosme de Burgos or some other early writer made the statement used by Juan Pio Perez that the katuns were named after the second days of certain Cauac years. It does not appear, however, that this Katun 2 Ahau was specifically stated as an example of operation.

Nakuk Pech[2] and Macan Pech[3] say:

> The year 1517: in that year they ceased taking the katun, they ceased setting up the town-stone for a. each twentieth tun they were wont to set up the town-stone; as yet the Spaniards had not come for the second time to the region; after the coming of the Spaniards it ceased to be done.

The evidence for Katun 2 Ahau strongly favors arrangement A, which also demands a Katun 13 Ahau ending in 1536 on 13 Ahau 8 Kankin.

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[1] The date 1511 for the arrival of the shipwrecked Spaniards, of whom Jeronimo de Aguilar was the most famous survivor, is given by Nakuk Pech, Macan Pech and Bishop Diego de Landa. Less than 7 but more than 6 tuns before the katun gives, according to B, 1513-14; A, 1509-10; C, 1506-07.

[2] Brinton, 1882, *a*, pp. 202-203 and 226-227.

[3] Martinez, 1926, *b*, p. 16.

Katun 13 Ahau: B=1539, A=1536, C=1532.

Juan Pio Perez gives 1536 as the year when a katun ended but his sources are unknown. The occult katun wheels of the Books of Chilam Balam and an illustration in Cogulludo point strongly to the confusion of the katun ending at this time with the death of Napot Xiu. Both Morley[1] and Spinden[2] have examined these katun wheels, with their prophesies of the various katuns and the ceremonial cycle of places and persons used in connection with katun dedications. The arrow stuck in the eye of the head for Katun 13 Ahau has been confused with the death of a priest of Mani called Ahkin Chi, supposed to be the father of the Gaspar Antonio Xiu, who rose to be the official interpreter. The heads are labelled Ah Kin Chil Koba and carry the number 13 (see Figure 4).

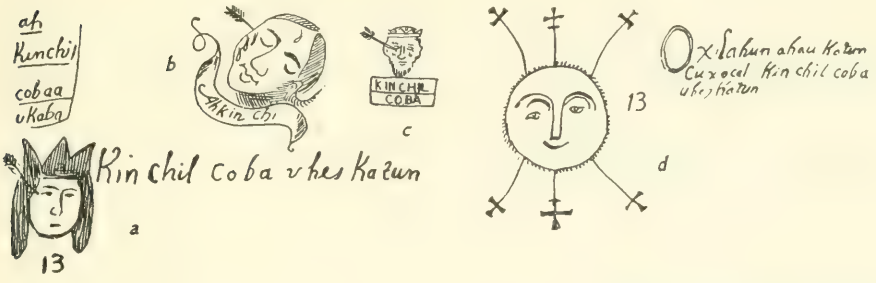

Fig. 4. Mystical references to the closing of Katun 13 Ahau in 1536, confused with the death of Ahkin Chi.

There are statements in connection with Katun 13 Ahau in various passages of the Book of Chilam Balam of Chumayel but they cast little light upon our problem. For instance, on page 85 of this manuscript we read "Katun 13 Ahau, first appeared the ship of the strangers at Campeche." This is most likely a reference to the disastrous attempt of Cordova to fill his water casks in 1517 or it may refer to the base established there by Montejo in 1531.

Katun 11 Ahau, B=1559, A=1556, C=1552.

The best information concerning the end of Katun 13 Ahau is obtained from very clear references to events in Katun 11 Ahau, and especially to the founding of Merida. The Spaniards arrived in the region of Ichcaanzihoo or Tiho, an ancient ruined city, in 1541 and on January 6, 1542, O.S., they founded their capital on this site. The deserted buildings of the Mayas reminded them of the Roman ruins at Merida in Spain,

[1] 1920, pp. 472-473; 478-487.
[2] 1924, pp. 89-90.

hence the name.[1] Nakuk Pech says in his Chronicle of Chicxulubchen: "The fifth division[2] of Katun 11 Ahau was placed when the Spaniards arrived and settled the city of Merida." An identical Maya text in the Chronicle of Yaxkukul is translated as follows by Martinez:[3] "At the fifth division when was established the idol of Buluc Ahau, then it was that the Spaniards returned and settled themselves there in that city of Tiho."

Both Nakuk Pech and Macan Pech agree again in another passage which correctly states the Maya year-bearer for 1541-42. The renderings of Brinton and Martinez are:

Brinton[4]:

The third time they arrived they settled permanently, in the year 1542 they settled permanently in the territory of Merida, Kan being the year bearer according to the Maya reckoning.

Martinez[5]:

The third time they arrived was when they definitely settled, that was the year 1542. It was then that they definitely established themselves here in Ichcaanzihoo where now they are, the year 13 Kan was the dominical or regent year according to the Maya count.

These statements are in exact agreement with the correlation which places Katun 2 Ahau of the Discovery in 1516 and Katun 13 Ahau of First Campaigns in 1536 but not as regards B and C which call for the end of the latter in 1539 and 1532 respectively.

A less explicit but still accurate statement is found on page 85 of the Chumayel Manuscript:

This year 1542 it was, wherein was founded the district of Tiho, Ichcaanzihoo, Katun 11 Ahau it was, and the first ruler was Don Francisco Montejo, the Adelantado. Then the towns were given to the strangers, the strong men; in the year 1542 the tribute began, 1545 was the year when the fathers came . . . it happened four years after the strangers came, and then also began baptism . . . and the towns were divided.

Katun 11 Ahau is preeminently the Katun of the Spanish Conquest but only in one place do we have an explicit statement of a tun, namely in Chronicle IV where Tun 7 is mentioned. We have seen that the foundation of Merida took place after the placing of Tun 5 and during the course of Tun 6. In the present connection Tun 7 may mean the consolidation of the Spanish Conquest over all northern Yucatan.

Landa is pretty clearly in error when he says:[6]

The Indians say, for example, that the Spaniards first arrived at the city of Merida in the year of the nativity of our Lord 1541, which was precisely the first year of the era of Buluc Ahau . . . and that they arrived in the very month of Pop, which is the first month of this year.

[1] Relaciones de Yucatan I. p. 54.
[2] The word used is *tzuc* which is here equivalent to *tun*. The fifth tun after the placing of Katun 13 Ahau, or the fifth tun in a current katun due to end on 11 Ahau, occurred considerably less than a year before the foundation.
[3] 1926, *b*, p. 5.
[4] 1882, *a*, p. 228.
[5] 1926, p. 18.
[6] 1864, pp. 314-316.

Perhaps Landa misunderstood his informant who might have said that the first quarter or hotun of Katun 11 Ahau was placed when the Spaniards reached the vicinity of Ichcaanzihoo during July, 1541. This apparently explicit statement of Landa has long been a stumbling block. It agrees with no other information and advances no tentative correlation, and must be ruled out as erroneous.

Katun 9 Ahau, B=1579, A=1575, C=1572.

In Katun 9 Ahau came Bishop Toral who ended the reign of terror inaugurated by Diego de Landa as head of the Inquisition. Christianity had been introduced on an effective scale in 1545 with the arrival of several friars, but Toral was the first resident bishop and he arrived in time to take office on August 15, 1562. The most sharply focused statement is that in Chronicle IV which reads:

> Katun 9 Ahau: no stone was taken at this time, in this katun first came the bishop Friar Francisco Toral: he arrived in the sixth tun of Katun 9 Ahau.

The nearest approach is found in A, for according to this arrangement Bishop Toral arrived while Tun 7 still had some days to run.

Katun 7 Ahau, B=1598, A= 1595, C=1591.

Bishop Landa died on April 29, 1579 O.S. and in four places the Maya Chronicles state that this event fell in Katun 7 Ahau: since it does so in all three tentative bases our problem of elimination is not advanced.

Katun 3 Ahau, B=1638, A=1634, C=1631.

Passing out of the sixteenth century into the seventeenth, one or two references are evidence to the fact that a katun count was still maintained by pagan groups of Mayas. In 1618 two friars named Bartolomé de Fuensalida and Juan de Orbita tried to Christianize the Itza of the Lake Peten region. Canek, the chieftain replied to them according to Villagutierre[1]: "That the time had not arrived in which they were to put aside the adoration of the gods, because the age in which they were at this time was that which they called Oxahau which means Third Age."[2] Now we know these friars left Merida after a ceremony held on March 25 and they would surely have tried to reach Lake Peten during the dry season. But Katun 5 Ahau continued under B till September, 1618 so B must be eliminated. A and C are both possible.

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[1] 1704, pp. 105-106.
[2] Literally 3 Ahau or Katun 3 Ahau.

Katun 10 Ahau, B=1697, A=1694, C=1690.

The last reference is of a somewhat different kind in that it related to the effort of another priest, Andres de Avendaño y Loyola, to arrive at an actual correlation between the Maya ages or katuns. He was trying to defeat the Mayas with their own arguments.

It is obvious from Landa's description of about 1553 that the Spanish churchmen did not understand the Maya system; nevertheless, we know that a generation later they were arguing that certain pre-Spanish prophecies in connection with katuns had been forewarnings of Christianity. Landa does explain the annual calendar and the 52-year cycle of year-bearers and also says that the Mayas had a method of counting their times and affairs by ages or katuns which consisted of 20 years, and that "they counted thirteen of these twenties with one of the twenty signs of the month which they call Ahau, without order, unless it be in a backward order as they appear on the following round wheel." Yet it is interesting to note that the Katun 11 Ahau marked with a cross on the katun wheel of the Landa MS covered the time when he was collecting his data.

Villagutierre in a parenthetical note following the reference to Katun 3 Ahau and the Fuensalida-Orbita Mission of 1618 says:

> These barbarians most assuredly count their ages backwards or towards a determined number which having reached, they forget and return to the beginning of the count; because when they withdrew from Yucatan, now going on three hundred years ago, they said that it was the Eighth Age, and that the time foretold unto them was not due; and now they said that it was the Third Age, and that the time had not arrived.

But Avendaño had made a study of Maya time counts and reached a conclusion which while not quite correct nevertheless was nearly so. He writes in the relation of his voyage:

> I told them that I wished to speak to them of the old manner of reckoning which they use, both of days, months and ages, and to find out what age the present one might be (since for them one age consists only of twenty years) and what prophecy there was about the said year and age; for it is all recorded in certain books of a quarter of a yard high and about five fingers broad, made of the bark of trees folded from one side to the other like screens; each leaf of the thickness of a Mexican real of eight. These are painted on both sides with a variety of figures and characters (of the same kind as the Mexican Indians also used in their old times), which show not only the count of the said days, months and years but also the ages and prophecies which their idols and images announced to them, or, to speak more accurately, the devil by means of the worship which they pay to him in the form of some stones. These ages are thirteen in number; each age has its separate idol and its priest, with a separate prophecy of its events. These thirteen ages are divided into thirteen parts which divide this kingdom of Yucatan, and each age, with its idol, priest and prophecy, rules one of the thirteen parts of the land, according as they have divided it: I do not give the idols, priests, or parts of the land, so as not to cause trouble, although I have made a treatise on these old counts with all their differences and explanations, so that they may be evident to all, and the curious may learn about them, for, if we do not understand them, I affirm that the Indians can betray us face to face.

The chieftain of the Itzas pretended ignorance but Avendaño persisted in the demonstration and thereby really defeated himself for he had calculated katuns at an even 20 years, whereas in reality they were 7,200 days in length. Avendaño continues:

We agreed that four months thereafter was the time wanting to fill out the said period when all the older men should receive baptism. . . . And so . . . I should go back to the Governor who sent me till the said four months had passed.

This conference took place early in January 1696 and four months more would lead to April. If, therefore, Avendaño had counted by twenty years from 12- 9- 0- 0- 0, 13 Ahau 8 Kankin,[1] falling in April, 1536, he would have reached the same April date in 1696 for the termination of Katun 10 Ahau and the beginning of Katun 8 Ahau in which conversion was to take place. Actually, Katun 10 Ahau had ended nearly two years before according to A, while according to B it would not end until 1697. This argument, in view of the sagacity displayed in Avendaño's general statement about the Maya chronological system, gives very strong support to tentative Correlation A, and indeed, the weight of evidence bears heavily in favor of this adjustment throughout the record examined above.

Page 66 of the Chronicle of Oxkutzcab. There is, however, one much-quoted document calling for special consideration. No katun is mentioned on the loose page 66 of the Chronicle of Oxkutzcab (a page first published with translation and commentary by Morley and rejected by him as a legitimate record from the times mentioned in the text), but a sequence of tuns is recorded by calendar round dates and year-bearers. Although replete with errors the tun-ending dates obviously belong in the Long Count in conformity with Correlation B. It is necessary to correct every month statement and in only two cases out of thirteen is this correction for the normal one day shift which differentiates ancient from modern dates. The year-bearers and the Ahaus are usually correct and the European years correspond to the second part of the Maya years. I give the comparison without correcting the text.

TABLE IV

PAGE 66, CHRONICLE OF OXKUTZCAB, AND SECTION OF MAYA LONG COUNT

Year	Year-Bearer	Day	Month	Number	Day	Month
153....	.....	.....	18 Yaxkin	11–15–14– 0– 0,	2 Ahau	3 Mol
153....	5 Kan	.. Ahau	7 Yaxkin	11–15–15– 0– 0,	11 Ahau	18 Yaxkin
1535...	6 Muluc	.....	11 Ceh	11–15–16– 0– 0,	7 Ahau	13 Yaxkin
1536...	7 Ix	3 Ahau	7 Yaxkin	11–15–17– 0– 0,	3 Ahau	8 Yaxkin
1537...	8 Cauac	12 Ahau	2 Yaxkin	11–15–18– 0– 0,	12 Ahau	3 Yaxkin
1538...	9 Kan	8 Ahau	16 Xul	11–15–19– 0– 0,	8 Ahau	18 Xul
1539...	10 Muluc	4 Ahau	11 Xul	11–16– 0– 0– 0,	4 Ahau	13 Xul
1540...	11 Ix	13 Ahau	7.....	11–16– 1– 0– 0,	13 Ahau	8 Xul
1541...	12 Cauac	9 Ahau	2 Xul	11–16– 2– 0– 0,	9 Ahau	3 Xul
1542...	13 Kan	5 Ahau	16 Tzec	11–16– 3– 0– 0,	5 Ahau	18 Tzec
1543...	1 Muluc	1 Ahau	11 Tzec	11–16– 4– 0– 0,	1 Ahau	13 Tzec
1544...	2 Ix	10 Ahau	6 Tzec	11–16– 5– 0– 0,	10 Ahau	8 Tzec
1545...	13 Cauac	6 Ahau	1 Tzec	11–16– 6– 0– 0,	6 Ahau	3 Tzec

[1] As we shall see 8 Kankin in 1536 corresponded to April 12 OS or April 22 NS.

What is the explanation of this fumbling statement placed so early in the Spanish Conquest before any Mayas were capable of writing their language in Spanish script? In the first place it must be much later than the dates imply. For instance, under 1542 and the year bearer 13 Kan we find 5 Ahau 16 Tzec which we convert to 5 Ahau 18 Tzec. Now Seler[1] uses a passage from an unpublished portion of the Book of Chilam Balam of Mani to the effect that in a year 13 Kan beginning in 1593 a Katun 5 Ahau fell on 5 Ahau 17 Tzec which also we must convert to 5 Ahau 18 Tzec. Why was this date doing double and inconsistent duty as a tun ending in one arrangement and a katun ending in another?

This page 66 of the Chronicle of Oxkutzcab bears the notation that it was copied on the 29th of May, 1685, by a member of the Xiu family from "an ancient book, namely, in characters as they are called anares." This word anares or analtehes, as we find it in Villagutierre, is merely the Spanish word anales, badly spelled. It is not an ancient Maya name for a book with hieroglyphs. There may, of course, have been a few katun heads and other devices such as we find in the Books of Chilam Balam in the work from which this page was copied. These would justify the term characters but it is absurd to think that the substance could have been written in hieroglyphs. The references deal with celebrated facts, including the killing of the delegation from Mani at Otzmal which in the second half of the sixteenth century was much played up by Gaspar Antonio Xiu. The conclusion is irresistible that the original was written in Spanish script and if so it must have been compiled a generation, at least, after the Christian years which accompany the passage.

Moreover, a satisfactory explanation is forthcoming how a section of the Maya Long Count, just 13 katuns or 260 tuns old, could have been used for the erroneous layout of a Maya-Spanish chronicle.

How Prophecies of the Katuns Explain Lapses of 13 Katuns. The Mayas were accustomed to make prophecies for each katun as Avendaño says in the passage quoted above. They celebrated the closings of 7200-day periods in a ceremonial circuit. Each katun of the u kahlay katunob had a special district, a special priest and a special prophecy, the prophecy being prefigured, oracle-like, on the outstanding events of the last previous katun of the same designation. In the Books of Chilam Balam there are a considerable number of katun wheels and also there are passages in which crowned heads of the kings or high priests of katuns are shown in combinations with statements concerning the *uhetz katun* or ceremonial establishment of the time period at a special place. There are also several series of prophecies.

The first mention of a prophecy supposed to foretell the coming of the whites occurs in Landa and a fuller account of the same prophecy is found in the Relation of Merida compiled about 1580. Much of the in-

[1] Gesam. Abh. I, p. 580.

formation in this account is from the pen of Gaspar Antonio Xiu, interpreter general. He was a member of the Xiu family from Mani and enough of a politician to benefit himself and his townsfolk by skillful use of his office. In this relation we are told that a few years before Yucatan was conquered a certain priest called Chilam Balam delivered a prophecy saying that a bearded people would come out of the east with a Maltese cross against which the native gods would be powerless. They were destined to rule and should be received in peace. The account goes on to say that the prophet had a mantle woven to show the kind of tribute the Mayas must give and sent it to Moo Chan Xiu, the lord of Mani. Also he had stone crosses set in the courts of temples saying this was the green tree of the world. With the soothsayer's warning before them the people of Mani yielded at once to the Spaniards.[1]

Moo Chan Xiu is also named as the lord of Mani when the Spaniards entered for the final conquest.[2] The Prophecy of Chilam Balam accredited to a man of Cauich Chen near Mani has come down to us in Lizana's writings, although not, perhaps, in the original form. It begins thus: "Katun 13 Ahau was established when the Itzas were in power in Tancah." Now Tancah means Mayapan,[3] and we must understand that the prophecy was intended to compare the last previous Katun 13 Ahau, when the theocratic state established by Quetzalcoatl was still flourishing, with the return of his symbols, perhaps revamped as those of Christianity, in another Katun 13 Ahau actually ending in 1536. It is known that the Maltese cross was associated with Quetzalcoatl while the Toltecs of his time are generally pictured as bearded. There is a great mass of evidence concerning the approximation of the cult of Quetzalcoatl to Christian uses. The awaited return of this teacher was an important theme both in Yucatan and on the highlands of Mexico, and one, moreover, which greatly affected the fortunes of Cortes. We do not know the date when this prophecy was delivered but even if it were in 1516 at the close of Katun 2 Ahau the Mayas would not have been wholly ignorant of the Spaniards. Aguilar and Guerrero had been living with them in Yucatan since 1511. If made after 1516 the fate of Mexico might have cast a shadow of approaching events over the Maya soothsayer. The chant as recorded by Lizana is unmistakably Christianized. It and several other prophecies were perhaps touched up for missionary propaganda.

The main point for us is that this chant links two important dates in Maya chronology namely 11-16- 0- 0- 0, 13 Ahau 8 Xul "when the Itzas

[1] Relaciones de Yucatan I, pp. 44-45.
[2] Book of Chilam Balam of Chumayel, p. 85; passage translated in Morley, 1920, p. 485.
[3] See Brinton, 1882, *a*, Chronicle IV, pp. 170-175.
Tancah means "in the midst of the town" and is perhaps a reference to the *tecpan* of the Mexicans, that is the ceremonial center of Mayapan which was a walled enclosure. In Chronicle IV the phrase is *peten tancah Mayapan*, translated either "the district in the middle of Mayapan" or "the district of Tancah Mayapan." Lizana, in his translation, interpolates as follows: "At the end of the thirteenth age, the Itzas being in their power at the city named Tancah, which is between Yacman and Tichaquillo, that today is called Ychpaa, that is fortress or castle." But Mayapan was depopulated before the coming of the Spaniards and we find no references to any reoccupation or ceremonial visitations.

were in Tancah" and 12- 9- 0- 0- 0, 13 Ahau 8 Kankin when the Mayas were facing a militant and ruthless Christianity. The next prophecy intended for a Katun 13 Ahau, found as the last entry in the Tizimin series, very clearly pictures the day of judgment, a comment worthy of the cataclysmic prototype which had brought the Spaniards.

I first give the Prophecy of Chilam Balam of Cauich Chen arguing from 11-16- 0- 0- 0, 13 Ahau 8 Xul to 12- 9- 0- 0- 0, 13 Ahau 8 Kankin, when the Spaniards came with a promise of spiritual benefit. Then I give the prophecy prepared for the next recurrence, namely 13- 2- 0- 0- 0, 13 Ahau 3 Zotz, when the world should end.

I. Prophecy of Chilam Balam of Cauich Chen

Katun 13 Ahau was established when the Itzas were in Tancah.

Oh Father! the sign of the only God on high is the cross, the wooden cross. This will be shown to the world so day will break over the world.

Oh Father long ago there began dissentions and confusion when we came bringing the sign. . . .

A mile away it comes! You will see fame coming with the cross of wood. It will illumine the four corners of the world. . . .

Oh Itzas! your father is coming! Your brother is coming to be placed ahead of all. Receive your guests, the bearded ones, people of the east, carriers of the sign of God the Lord.

The Lord comes to your company to arrange His word, to establish the new life. Do not fear Him who is above the earth.

Oh Father! you are the only God who created us. Good in themselves are the words of God, the Father, the guardian of our souls.

He who accepts the true faith goes upward to heaven. Our day is come.

We praise His sign on high, we praise His cross of wood. Instead of misery and discord restore the first tree of the world. Show this now to the world, the sign of the only God on high.

You, Oh Itzas! make reverence all, revere the one on high, revere with true hearts and worship Him, our true God. Now receive the word of the only God who speaks to you from on high, who comes from on high.

Recover your good will, Oh Itzas, the earth is enlightened.

The spirit enters into another katun: believe my words: I am Chilam Balam. I have interpreted the word of the true God among all the places of the Earth, that the people everywhere may know.

II. The Prophecy of the Last Katun, Tizimin MS

13 Ahau is the 13th Katun according to the count.

At Cabal-ix-bach-can is the katun established.

Darkened shall be its page.

The sun shall be darkened, the face of the moon shall be darkened. There shall be blood among the trees and rocks. Sky and earth shall burn.

Then shall come the everlasting judgment of the living and the dead. The dead shall come to life. The trumpet shall sound on high.

The righteous shall ascend on high and the wicked shall go down to the dark land at the end of the katun.

This, the prophecy of the Lord of Heaven and Earth, the destiny of 13 Ahau, on the day when it ends it shall be.

The sequence and the argument are unmistakable. But the total evidence from the several sets of katun prophecies which have survived indicates that a cycle was put in order about a century after the Spanish Conquest. Five katuns in sequence beginning with the one for Katun 11 Ahau, are established in Ichcaanzihoo, that is, Merida, the seat of the

Spanish church. Most of the other texts may hark back to pre-Spanish times, a few of them certainly do.

The tense is more often past or present rather than future. One or two compositions might, indeed, be historical summaries such as the prophecy of Katun 9 Ahau covering the persecutions of the Mayas under the fanatical Landa. I know of few more telling indictments directed at their conquerors by a conquered people than this outcry of the disillusioned natives of Yucatan. I quote the latter part of Roys' translation out of the difficult Maya text:

> Then began the building of the church here in the center of Tihoo. Great labor is the destiny of the katun.
>
> Then began the execution by hanging and the fire at the ends of their hands. Then also came ropes and cords unto the world.
>
> Then the children of the younger brothers came under the hardship of legal summons and tribute.
>
> Tribute was introduced on a large scale and Christianity was introduced on a large scale.
>
> Then the seven sacraments of the word of God were established.
>
> Receive your guests heartily; our elder brothers come!

Anyone who studies the poor town books of Yucatan which the Mayas beginning at the end of the sixteenth century made the repositories of scraps of history, of magic, of medicine, of astronomy, cannot but be conscious how the darkness of ignorance closed down on the last flickering lights of Maya learning. A change came over the patterns of time. Order was lost or warped into occult and cabalistic formulæ. Knowledge of the katuns and of the districts in which the closing dates were celebrated was about the last thing to be lost. Doubtless the priests in each district held fast to the slender memorabilia of earlier visitations of the ceremonies. The mere possession of chance bits of antiquarian information was a liability leading to confusion. In the case of the disconnected page 66 of the Chronicle of Oxkutzcab, it seems probable that a fragment of ancient time scale was reissued, as of thirteen katuns after the true state.

The Maya Chronicles and the Basic Correlations. After this digression into a byway that furnishes no real proof, only providing a plausible explanation for what otherwise might be trouble-making anomaly, we return to the broad high road of demonstration. We now deal with the gross effects of applying the three structural correlations to the total range of Maya history.

It is at once apparent that A, B and C operate in different ways upon:

1. The dates recorded on ancient monuments.
2. The dates recorded in the Chronicles.

The dated monuments of the First Empire extending from 8- 6- 2- 4-17, 8 Caban 0 Kankin on the Tuxtla Statuette to 10- 3- 0- 0- 0, 1 Ahau 3 Yaxkin on Stela 12 at Uaxactun have the following ranges in chronology according to the three values of Katun 13 Ahau of the Conquest:

B. For 11-16- 0- 0- 0, 13 Ahau 8 Xul, the extent is from 162 A.D. to 889 A.D.

A. For 12- 9- 0- 0- 0, 13 Ahau 8 Kankin, the extent is from 98 B.C. to 629 A.D.

C. For 13- 2- 0- 0- 0, 13 Ahau 3 Zotz, the extent is from 368 B.C. to 369 A.D.

The Maya Chronicles as they stand contain a definite number of katuns, the total extent of which in European chronology depends upon the slightly different take-offs for the three katun-endings A, B and C. We have seen that there is a difference of 1300 days in these bases. The correspondence in the Long Count for the first Katun 8 Ahau of Chronicles I and II is necessarily found at a distance of 69 katuns (3- 9- 0- 0- 0), for each value of Katun 13 Ahau of the Conquest, as follows:

B.	11–16– 0– 0– 0,	13 Ahau	8 Xul	1539 A.D.
	3– 9– 0– 0– 0			
	8– 7– 0– 0– 0,	8 Ahau	13 Zotz	179 A.D.
A.	12– 9– 0– 0– 0,	13 Ahau	8 Kankin	1536 A.D.
	3– 9– 0– 0– 0			
	9– 0– 0– 0– 0,	8 Ahau	13 Ceh	176 A.D.
C.	13– 2– 0– 0– 0,	13 Ahau	3 Zotz	1532 A.D.
	3– 9– 0– 0– 0			
	9–13– 0– 0– 0,	8 Ahau	8 Uo	172 A.D.

It is apparent at first glance that B finds for the first date of Chronicle I and II a position that nearly coincides with the first contemporary date inscribed on an object, while A reaches an even baktun. The second coincidence seems more important especially as it can easily be shown that the first dated object does not stand, in any sense, at an historical zero for the inscriptions. The even baktun, 9- 0- 0- 0- 0, 8 Ahau 13 Ceh, on the other hand, might easily be taken as ushering in the Maya epoch of greatness. Only a few contemporarily dated monuments precede this round number in the Long Count. Arrangement C eliminates from the scope of the Chronicles an important period in Maya history covered by a mass of monuments.

Another test has been applied to this matter by Morley who pointed out in 1910 that the best cross-reference between the inscriptions and the Chronicles is found in the Initial Series date at Chichen Itza which must fall during an occupation of this city. The date is 10- 2- 9- 1- 9, 9 Muluc 7 Zac, and the city was occupied according to the Chronicles not earlier than 450 A.D. and was abandoned about 630 A.D. It was unoccupied from this date till about 960 A.D. and then was occupied till about 1450 A.D.

B. For the correlation based on 11-16- 0- 0- 0, 13 Ahau 8 Xul, and 1539, the date at Chichen Itza falls in 879 A.D. or during the period of abandonment.

A. For the correlation based on 12- 9- 0- 0- 0, 13 Ahau 8 Kankin, and 1536, the date at Chichen Itza falls in 619 A.D., or during the first occupation, and the subsequent abandonment of Chichen Itza according to the Chronicles then practically coincides with the end of the First Empire, for the last date is 10- 3- 0- 0- 0, 1 Ahau 3 Yax.

C. For the correlation based on 13- 2- 0- 0- 0, 13 Ahau 3 Zotz, and 1532, the date at Chichen Itza falls in 359 A.D. or before the first occupation.

By this demonstration Correlation A again emerges as by far the most consistent and probable of the three under consideration.

Can the Maya Chronicles be Syncopated? It has been suggested that if the Maya Chronicles could only be syncopated by one round of thirteen katuns, Correlation B would find a better adjustment in that the first date of the Chronicles would then be 9- 0- 0- 0- 0, 8 Ahau 13 Ceh, instead of 8- 7- 0- 0- 0, 8 Ahau 13 Zotz, and the Initial Series date at Chichen Itza would then fall during a recorded occupation of that city. Eric Thompson and Juan Martinez, both favoring Correlation B, have sought ways and means to accomplish such a syncopation. As I understand the matter Martinez prefers an excision immediately before the Conquest while Thompson would eliminate the middle period of Maya history between the fall of the First Empire and the beginning of the Second Empire or, let us say, the reoccupation of Chichen Itza.

There has long been the practical conformity in opinion as to the sequence of events in the Maya Chronicles, and this in spite of the fact that these contain obvious discrepancies. For a long time Chronicle I of Mani was the only published text. Brinton,[1] Morley,[2] and Spinden[3] correlated all texts without emendations of a major character. There are, to be sure, several confused passages and a reduplication of katun names without historical entries in Chronicle II, but an additional excision of thirteen katuns, affecting all Chronicles cannot be made without profoundly disturbing a fabric of relations partly determinable by outside sources of information. Thompson's attempted syncopation and readjustment[4] does violence in several places.

To begin with he uses the terms First Empire and Second Empire (or Old Empire and New Empire, if you will) in a geographical rather than a chronological sense. Applying Correlation B he makes the last date at Uaxactun 889 A.D. yet he calls Stela 1 at Tulum a New Empire monument dated 564 A.D. This provides an overlap of over 300 years during which the culmination of Maya civilization actually took place. But the contemporary sculptures and inscriptions of northern Yucatan are part and parcel of the same Maya civilization encountered at Copan and Palenque.

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[1] 1882, a.
[2] 1910 and 1920, p.
[3] 1913, table 2.
[4] 1928, p. 102.

The arrangement controlling dates for Chichen Itza by Thompson has little semblance to the Chronicles. Fortunately, as has been said, other documents lend support to these documents as do facts obtained by archeological work. Thompson brings the discovery and occupation of Chichen Itza by syncopating the Chronicles one entire round of the u kahlay katunob nearer the present, making thereafter a number of shifts to equalize, after a fashion, the strain on chronology. He puts the settlement of Chichen Itza in 711 while the abandonment is delayed till 929, a scope which takes care of the Initial Series as transcribed by Correlation B. The Itzas move to Chanputun or Chakanputun occupying this region till 1204. Meanwhile the Tutul Xiu are said to have set out from Nonoual in 948, moving first to Bacalar and then to Chichen Itza which they enter in 1027, the place having lain empty for a hundred years. In 1145 the city is destroyed over the heads of the Tutul Xiu who migrate to Chanputun although that region is still occupied by the Itzas. Here there is warfare, apparently of desultory character. The Itzas begin to withdraw in 1204 and by 1265 have reoccupied Chichen Itza, their old capital. Meanwhile the Tutul Xiu establish Uxmal. The League of Mayapan, according to Thompson, then begins and runs till 1461. This arrangement does not respond to recorded and generally accepted dates except approximately in the last item.

It is not possible to go as deeply as I might wish into some of the essentials which Thompson presupposes. But doubt may be expressed whether the Itzas and the Tutul Xiu can be differentiated as regards origin. Both are probably intruders. The original name of the city called Chichen Itza, what was it? We speak of the Maya civilization but we do not know the real name of the people who created the splendid First Empire. The name Maya is defined by the Indians of eastern Yucatan as one applied to a vile and low mixture, found in the region to the westward of Valladolid. The Itzas are called talkers of gibberish[1] and the Tutul Xiu are upbraided as strangers. The likelihood is that all three groups differed from the original inhabitants of Yucatan. The Toltecs carved on the walls of Chichen Ltza nearly all wear the turquoise bird on their foreheads, the crest which gives rise to the very name Tutul Xiu (xuih tolotl or turquoise bird in Aztec). The Maya name Tanupol Chicbul, meaning the jay-bird on the forehead, was used by a certain person claiming Mexican lineage.[2]

Thompson's rearrangement disturbs the epoch of Quetzalcoatl which appears, on good evidence,[3] to have extended from 1161 to 1208. This

[1] The coming of the Itzas is dealt with in these words:
"There was no great teacher, there was no head priest at the time of the change of rulers, when this people reached here. Dissolute was the priesthood when the change was accomplished here by the foreigners. Then the men of birth were repudiated, here in the midst of the town. Then tribulations were put upon them; then came the affliction of these foreigners. These indeed were the Itzas."

[2] See Brinton, 1882, a, pp. 120-121.

[3] Data on the astronomical feats of Quetzalcoatl is presented below (see page 34).

Quetzalcoatl was a prominent personage in Mexican and Guatemalan history as well as in the history of Yucatan. Interrelated matter of the Chronicles and the Maya texts translated by Roys[1] make us reasonably sure that Nacxitl-Quetzalcoatl, alias Kukulcan and Hunac Ceel, "trampled on Chac Xib Chac of Chichen Itza" in Tun 10 of a katun due to terminate on 8 Ahau. This was some 345 years before a katun terminated on 13 Ahau, in 1536 according to Correlation A, or in 1539 according to Correlation B. We thus have 1191-1194 A.D. for the beginning of the Toltec transformation in architecture and ceremonies at Chichen Itza which followed the overthrow of the native dynasty. Thompson has Chichen Itza unoccupied at this time.

The League of Mayapan according to Landa and others was the political creation of Quetzalcoatl. After a stormy career this league ended in the breakdown of political structure in Yucatan. This breakdown was marked by the abandonment of Chichen Itza, Uxmal, Mayapan, Izamal and other stone-built cities in the Katun 8 Ahau which extended from 1437 to 1457 according to Correlation A or about 4 years later under B. There are close estimates on the time of this end of urban civilization in Landa and the many relations of the Spanish landholders made by royal order in 1580. The Chronicle of Tizimin implies[2] that the rule of Mayapan lasted 14 katuns or about 280 years. The foundation took place, then, in Katun 10 Ahau, 1161-1181 A.D., a time within easy reach of the revolt which the founder of the league himself suppressed in 1191.

Many relations repeat a statement, perhaps drawn from Gaspar Antonio Xiu's lost work, that the lords of Chichen Itza had an undisturbed rule of 200 years. During this halcyon period there was no human sacrifice. There was a firm belief in Yucatan that human sacrifice was introduced by Quetzalcoatl, or rather his fellow Toltecs coming from the highlands of Mexico.[3] Now 200 years before the date reached for the beginning of the League of Mayapan leads exactly to the time when Chichen Itza was reoccupied according to the Chronicles, namely, in a Katun 4 Ahau which extended from 964 to 984 A.D.

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[1] 1922, pp. 45-47.

[2] The text runs "Katun 8 Ahau. Mayapan was depopulated by foreigners from the mountains; tenscore years and fourscore years." Brinton, 1882, *a*, p. 148.

[3] I quote repeated passages in the relations of the landholders of Yucatan written in 1580.

a. "Once all this land was under one lord in the time when reigned the lords of Chichen Itza and this reign endured for more than 200 years. After much time the city of Mayapan was founded where the absolute lord was one they call Tutul Xiu from whom descended the natural lords of the town of Mani." (Relations of Yucatan I, pp. 176; 193; 200; 242.)

b. "It is said that the first population of Chichen Itza were not idolaters until Kukulcan, a Mexican captain, entered these parts. He taught idolatry or necessity as they say taught them to worship idols." (Relations of Yucatan I, pp. 121; 215; 226; 270.)

c. "Once all this land was under the dominion of a lord who kept his state in the ancient city of Chichen Itza to whom were tributary all the lords of this province and even beyond the province. From Mexico, Guatemala, Chiapas and other provinces they sent him presents in sign of peace and friendship. And with the passing of time and Mayapan being founded, then Tutul Xiu made himself master of it. . . . " (Relations of Yucatan I, pp. 120; 214; 270.)

d. "The ancient say of this province that anciently, about 800 years ago, there was no worshipping of idols in this land and that afterwards the Mexicans entered and conquered it. A captain whom they call Quetzalcoatl in the Mexican language which means in ours 'plumage of serpent' . . . introduced idolatry into this land. . . . " (Relations of Yucatan I, p. 255.)

e. "They were subjects of a lord they call Tutul Xiu, a Mexican name, who, they say, was a stranger from the west. After he had arrived in this province, the leaders raised him by common consent to be king, seeing his valorous character. Before he came, they were subjects to the Cocom who was the natural lord of a large part of these provinces. . . ."

Let us turn to the passages in Chronicles I and II which interrelate Chichen Itza and Uxmal. The abandonment of Chanputum or Chakanputun, the region of central Yucatan in which architectural types transitional between First Empire and Second Empire buildings are found, is placed in the Katun 8 Ahau running from 925 to 944 A.D. (with only 3 or 4 years to be added if Correlation B is used). This region had been occupied for approximately 260 years, the Mayas having chosen it after the first abandonment of Chichen Itza (which coincided with the collapse of the First Empire about 630 A.D.[1])

In the Chronicle of Mani the founder of Uxmal is named as Ah Zuitok Tutul Xiu who established the city in Katun 2 Ahau (984-1004) shortly after the reoccupation of Chichen Itza. Then follows 200 years devoid of comment. In the Chronicles of Tizimin, at the end of a similar 200 years the same Ah Zuitok Tutul Xiu is named as founder and the accompanying statement seems to mean that 200 years had passed since the foundation. These 200 years are probably to be identified with those of the undisputed rule of Chichen Itza before the League of Mayapan effectively divided the power. Landa says that the foreigners at Uxmal had been allowed quietly to grow in numbers and influence. Finally, there may have been an additional influx of the same people from the Mexican highlands bringing the developed complex of Toltec religion.

Archeologists recognize in Chichen Itza a considerable number of buildings, including the Nunnery and the Akabtcib, which are of a widespread Yucatan type but without evidences of Toltec influence. These probably represent the art of Chichen Itza before Quetzalcoatl's victory of 1191. The Temple of Quetzalcoatl and the Round Tower, both associated with this conqueror, are likewise the earliest and most primitive examples of the peculiar architecture generally recognized as having affiliations with that of the Mexican highlands. Other references to times before the Toltecs elsewhere in northern Yucatan are found. In the Relation of Motul, for instance, we are told that Zac Motul founded the city and that his descendants ruled there for 120 years before being conquered by a certain leader called Kakupacal. We hear more of this raider who had with him a hundred valorous warriors "of the Itzas who were those who settled at Mayapan," elsewhere described as "those from whom descend the Xius and the Mexican Indians of these provinces."[2]

Beginning with the League of Mayapan the record is confused in the Chronicles but we find considerable outside information. The revolt led by the old nobility of Chichen Itza found an able ally in a young man

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[1] Nearly always a katun or two is required for reorganization after a cataclysm leading to abandonment, according to the Chronicles. The second regime of Chichen Itza begins 40 years after the flight from Chakanputun. In this interim the people are described as being "under the trees, under the boughs, under the branches to their sorrow."

[2] Relations of Yucatan I, pp. 77; 119; 213; 224 and 269. The captain's name also appears Kanupacal. He may be the same as Cacalpuc of the lawsuits translated by Brinton, 1880, *a*, pp. 114-121.

who founded the ruling House of the Chel.[1] Even though Quetzalcoatl won and took Chichen Itza as the spoils of war, the spirit of rebellion would not down. The control of Mayapan changed hands several times between the House of Cocom and the House of Tutul Xiu, the last named recognized as dominant in Uxmal. After the crash we find the people of Mani claiming to be special heirs of the ceremonies introduced by Quetzalcoatl. The bitterness engendered by generations of civil war did not die out. It doubtless had much to do with the Tutul Xiu becoming allies of the Spaniards during the Conquest.

The scheme of Thompson and Martinez to excise thirteen katuns from the Maya Chronicles finds no support in the documentary side of Maya history. Nor can it be justified on the archeological side. There is a wide break between architectural styles of the First and Second Empire and it is precisely in the central region which appears as Chanputun or Chakanputun in the Chronicles that the intermediate styles of architecture occur.

We can trace in the latest buildings of the First Empire the earliest trend towards certain characteristic features of Middle Period architecture, such as terminal towers on long buildings. We can trace in the buildings of this Middle or Transitional Period the first stages of architectural features found in developed or decadent form in buildings of the Second Empire. Among such features may be mentioned the earliest banded columnar decoration, both at the corners of buildings and in the upper zones, the earliest panels of lattice work, the earliest intertwined serpents in façade decorations, etc. Also it seems that certain fine styles develop, flourish and practically pass away during this intermediate period. There are the terminal towers, mentioned above, with their "hanging" stairways. There are characteristic handlings of corner masks and the beautiful development of the three-unit façades, with a great front view face over the door and profile serpents on either side, such as culminate at Hochob. Maya architecture surely did not modify more rapidly than European.

Only in one or two structures at Uxmal and Chichen Itza, notably the splendid Annex to the House of the Magician at the former city and the equally famous Eastern Façade of the Nunnery at Chichen Itza are discernable the last echoes of Middle Period triumphs. When the Second Empire does come in, several new features appear, such as half vaults under "flying" stairways, single-wall flying façades and finally columns in doorways, the last feature probably of Mexican origin.

Ancient dated monuments at several Second Empire cities may be taken as evidence of previous occupations during the First Empire. But at these places we find no First Empire buildings nor any that can be

[1] The story of Ah Chel, his flight from Mayapan and the part he afterwards played is told in the Relation of Canzacabo, and the Relation of Izamal and Santa Maria as well as in Landa's narrative.

referred to the Middle or Transitional Period. It is especially to be noted at Chichen Itza that the architectural record of the first accredited occupation is nil. The Lintel of the Initial Series has an ancient date but it is merely a reused stone. Tulum had one early monument, early even for the First Empire, but architecturally Tulum is one of the latest Maya cities. At Koba a large number of stelae with ancient dates are known to exist but the buildings there are also very late. It is, of course, possible that all these sculptures were collected by the Mayas from ancient ruins and set up as sacred relics. At Etzna about the same problem exists, for the lofty temple is not of the same date as the weather-worn monuments set up before it. Uxmal is now reported to have its quota of early monuments. It has what may be the earliest structures of any Second Empire city in the two small temples almost buried under the platform of the House of the Governor. Here at least there is a reminiscence of the art of Dzibilnocac and Hochob, of Santa Rosaura and Rio Bec, which flourished after the fall of First Empire and before the establishment of the New Empire. It is unfortunate that the pottery and minor arts of the Middle Period are as yet too little known for one to venture opinions of relative age on that score.

To eliminate the time which now intervenes between the close of the First Empire about 630 A.D. and the opening of the Second Empire with the reoccupation of Chichen Itza about 960 A.D. for the purpose of developing a doubtful advantage for Correlation B would be to play fast and loose with both the historical and archeological record.

The Day-for-Day Correlation. We now leave for the moment the matter of the larger time periods of the Mayas and direct our attention to data which bears on the exact placing of Maya days of the tzolkin in chronology. Here the evidence is scanty but precise enough, covering early almanacs, a few double dates, and a mass of evidence which discloses a general coincidence of similarly designated days among all the varieties of the Central American calendar.

Early almanacs in which the terms of a Spanish year are confronted with the terms of a Maya year occur in Landa and in four of the town records known as Books of Chilam Balam. Although at first glance contradictory, these sources can be reduced to a consistent chronology.

Landa's double almanac relates precisely to the Maya year 12 Kan which can be no other than the year of that name beginning in 1553 and running into 1554. We know that Landa came to Yucatan in 1548 and that he was called to Spain for trial before the Council of the Indies in 1562. We also know that during his forced sojourn in Spain he wrote out his *Relation of the Things of Yucatan* which contains all the evidence he had been able to collect on the Mayas. Whether he actually was the first to compile the almanac found among the precious excerpts from his lost relation is another question. At least it seems likely that copies of

this almanac existed in Yucatan during the sixteenth and seventeenth centuries and it is not impossible that Tomas Lopez who was in Yucatan in 1553, as the first Auditor, was responsible for its compilation.

We have stated that the chronological position of the Landa almanac is revealed by 12 Kan as year bearer in the Maya year. The equation 12 Kan 2 Pop, July 16, 1553, O.S. is a perfect double date derived from the typical year of Landa. It is perhaps the most important evidence leading to our day-for-day correlation especially as it conforms either exactly or within a day to the cognate native calendars of Mexico and Guatemala. It is true that the year 1553 is not mentioned in Landa's text. We do find, however, the Sunday letter, a capital A, joined with 12 Kan on July 16 and July 16, 1553, actually was Sunday.

Further examination of the Landa almanac discloses that the Maya year 12 Kan is broken into two parts. The first part, 12 Kan 2 Pop to 11 Eb 10 Chen, runs properly enough in conjunction with the days of 1553 which begin with July 16 and end with December 31. The second part of the Maya year, 12 Ben 11 Chen to 12 Lamat 1 Pop, is swung round in front and put in conjunction with January 1 to July 15 of this same year 1553 although really belonging to the corresponding portion of 1554. Far from being a discrepancy, the shift is strong proof that confrontation of Maya and European days was actually compiled during the latter part of the European year 1553.

Another almanac is found in four redactions in the Books of Chilam Balam of Tizimin (pages 41-52), of Kaua (pages 54-71), of Nah (pages 3-14) and of Tekax (pages 1-10, with January missing).[1] In this repeated almanac the Maya months begin at exactly the same places in the European year as in Landa's compilation. This is a remarkable circumstance since Maya months belong in a calendar of just 365 days and recede in the European year according to the rate of our leap year interpolations. Any correlation normally holds good for only a four-year period. When, therefore, we find Landa's system with Yax beginning

[1] The most primitive redaction is that of the Tizimin MS. Here the Maya day names are spelled out, numeral and all, in Spanish script. Lahun Oc, or 10 Oc, is opposite January 1st. Each day is then classified as "good" or "bad" by the Maya words *utz* or *lob*. Also at intervals there are phrases in Maya which refer to the activities of the so-called "burner," these being part of the tzolkin formula to determine luck. The Maya months are indicated in the margin opposite the days named Imix for the first part of the year and Cimi for the second part beginning with Pop. In several places opposite possible years bearers we read *u hun te Pop*, that is, "the first of Pop." One of these is 7 Kan on April 25th, another, 5 Ix on June 14th, and a third, 6 Cauac on September 27. These statements may imply that the writer was aware, first that Kan, Muluc, Ix and Cauac were properly to be found on the first of Pop, secondly that he could calculate the recession of the Maya year in the European year. Thus a year 7 Kan would begin approximately on June 14th in 1715 and a year 5 Ix approximately on April 25th in 1925. As regards the Spanish part of the almanac of the Tizimin MS week day letters are omitted and only a few saint days are recorded.

The redaction in the Kaua MS is fullest of all. Here the days of the European week are indicated by the first seven letters of the alphabet, the saints days of the Roman church are fully stated and the signs of the zodiac are put down. It seems that the original material may have been amplified by new material taken from an illustrated Spanish almanac or lunario. On the Maya side each day is as before and the lucky and unlucky days are pointed out. Also the days Kan, Muluc, Ix and Cauac are printed in heavy type to emphasize their importance even though they are displaced from the proper position in the native months.

In the redactions of the Nah and Tekax MSS. the numerical coefficients of the Maya days are omitted but we still find the year beginning with Oc on January 1st and the Maya months are in their old places beginning with Yax on January 12th.

on January 12 and Pop on July 16 repeated in the various copies of the Books of Chilam Balam, as well as in publications by Sanchez de Aguilar and Diego de Cogolludo dating from long after the Gregorian correction, the uniformity calls for our suspicious scrutiny.

A second criterion counts heavily against the almanac repeated in the Books of Chilam Balam as a document of high credibility and early date. The beginning days of the Maya months are Imix for the first part and Cimi for the second part after the 5 day Uayeb period. These days cannot in any variant of the Central America calendar occupy such places and in Yucatan the eligible days are Kan, Muluc, Ix and Cauac. It seems that this almanac has suffered a three-day shift in the organic arrangement of the Maya material. Once this fault is corrected it becomes apparent that the pattern of a single European year is correlated with the second part of a Maya year 13 Kan and the first part of the following Maya year 1 Muluc. Two historical positions are suggested, namely, one in 1542 and one in 1594, the intervening Gregorian correction making the double adjustment possible. If the first position is taken, the argument must be either that the almanac rests on an original compilation actually antedating the specimen year of Landa, or that it was built up by calculation and predated to reach the same effect. If the second position is taken, the explanation is much easier. By 1594 there were native Mayas capable of using Spanish script in the writing of Maya words but in 1542 no Mayas were so qualified. It is a most suspicious coincidence that a three-day error in the placing of days—and this error on the Maya side—should join with the 10-day Gregorian shift of 1582 exactly to offset the recession of the Maya year during one calendar round. Also we

TABLE V

COMPARISON OF MAYA-SPANISH ALMANACS

Almanac of the Landa MS. for the Spanish year 1553 and the Maya year 12 Kan, 1553-54.

12 Kan 2 Pop	=	July 16, 1553	Julian Calendar	Year 12 Kan	begins
12 Ben 11 Chen	=	Jan. 1, 1554	" "	Year 1554	"

Almanac of the Books of Chilam Balam.

A. for the Spanish year 1542 and the Maya years 13 Kan, 1541–42 and 1 Muluc, 1542–43.

13 Kan 2 Pop	=	July 19, 1541	Julian Calendar	Year 13 Kan	begins
10 Oc 8 Chen	=	Jan. 1, 1542	" "	Year 1542	"
1 Muluc 2 Pop	=	July 19, 1542	" "	Year 1 Muluc	"

B. for the Spanish year 1594 and the Maya years 13 Kan 1593–94 and 1 Muluc, 1594–95.

13 Kan 2 Pop	=	July 16, 1593	Gregorian Calendar	Year 13 Kan	begins
10 Oc 8 Chen	=	Dec. 29, 1593	" "	Almanac	"
13 Ben 11 Chen	=	Jan. 1, 1594	" "	Year 1594	"
1 Muluc 2 Pop	=	July 16, 1594	" "	Year 1 Muluc	"

have already noted that late Yucatan authors make Pop begin on July 16, exactly as the Landa calendar does, although this was compiled in 1553 before the Gregorian correction—and a copy left in Spain when the acquitted churchman was allowed to return to Yucatan as the second resident bishop. Other copies doubtless existed in monastic libraries of Yucatan and were never brought up to date. The comparison given below seems to indicate that the second historical position of the almanac of the Books of Chilam is far the more likely.

Double dates focusing on actual days are conspicuously absent from the Maya-Spanish record. One such is 11 Chen 18 Zac, February 15, 1544 recorded in the Tizimin and Mani Books of Chilam Balam. This is 11 Chuen 19 Zac in the ancient calendar, under the year bearer 2 Ix. In reference to Landa's almanac this date is really about six days out of the way, corresponding to February 21 in the then prevailing Julian calendar instead of February 15.

There are the famous references to the death of Ahpula Napot Xiu, or water priest Napot Xiu, which are rather carefully defined but which have given rise to an endless controversy. In these statements the calendar round date 9 Imix 18 Zip (amended to 9 Imix 19 Zip) is placed where it belongs in a year 4 Kan which began in 1545 and not the recorded 1536. The great event of 1536 was the end of Katun 13 Ahau and if there was a massacre at that time it was either connected with the ceremonial setting up of the Katun stone or, as Landa suggests, with a special ceremony to end a drought. Cogolludo relates a story in which he disclaims belief to the effect that an embassy, sent out in 1541 by the Xius of Mani to obtain submission of all the Mayas to the Spaniards, was waylaid and killed. He found confusion in the records and thought the cause of enmity between the Xius and the Cocoms rested on an ancient and pre-Spanish event.

In the Chronicle of Nakuk Pech, as well as in the Chronicle of Yaxkukul of Macan Pech, there are clear references to a massacre famous among the Indians, which seems to have taken place in 1545. It involved the blinding of one man and the killing of others in a cave near Otzmal by members of the Cocom faction. Now under the day-for-day arrangement of Correlation A, explained below, 9 Imix 19 Zip is exactly September 23, 1545 the day of the autumnal equinox, and a most likely time for a ceremony. We also know that a violent revolution broke out the following year in which allies of the Spaniards suffered more heavily than the Spaniards themselves. It is quite likely that members of the Tutul Xiu family were killed at this time.

As regards Napot Xiu who is hailed as chief of the Xius there are important facts to hold in mind. One is that Moo Chan Xiu is named as the head of the Xiu family at the time the prophecy of Katun 13 Ahau was issued and probably also at the time of the permanent settlement of the Spaniards. Alonzo Rosado, one of the *conquistadores,* who was given the

town of Zan in the province of the Xius, writes as follows: "Its Lord was Napot Xiu who was governing the said town with its subjects when it was given to me in *encomienda.*" The distribution of the towns took place in 1542 and probably this Napot Xiu is the one referred to in the confused accounts. The data on Napot Xiu produces a stale mate from whatever point of view it is considered.

A third date is recorded in the Books of Chilam Balam of Mani and Tizimin according to Seler. This is 5 Ahau 17 Tzec (amended to 5 Ahau 18 Tzec) falling in the year 13 Kan, 1593-94 also corresponding to Katun 5 Ahau. As a calendar round date this comes under the proper year bearer but the only place in the Long Count with which it can be correlated is 3-11- 0- 0- 0, 5 Ahau 18 Tzec in the 4 Ahau Cycle following the important one which begins with 4 Ahau 8 Cumhu. But this is manifestly impossible; it would push the dates at First Empire cities into dim antiquity.

This ends the list of calendarial statements and it will be observed at once that the only complex of outstanding interest is the one depending on Landa's typical year with 12 Kan 2 Pop equalling July 16, 1553, in the Julian calendar or July 26 in our present Gregorian calendar.

The Chronological Identity of the Central American Calendars. Conformity of the Maya tzolkin, the Quiché-Cakchiquel ch'ol kih, and the Aztec tonalamatl is shown first in the analysis of names and secondly in the coincidence of equivalent days in the historical record, either exactly or within one day. This condition may be compared with the lexical and temporal conformity of the European week days in England, Spain and wherever used. The Maya day 1 Imix is cognate to Tzental 1 Mox; Jacalteca, 1 Imux; Quiché-Cakchiquel, 1 Imox; and is related in meaning to Aztec, 1 Cipactli; Zapotec, 1 Chilla, etc. In 1919 I wrote: "A highly important fact develops when the Maya and Aztec calendars are brought together after each has been correlated to the Gregorian day. This fact is the practical identity of the two time counts which has never before been assumed or demonstrated. It should be sufficient to remove any doubts engendered by unavoidable adjudication of evidence where authorities are in conflict." After writing the above, I was able to extend absolute identity between the 260-day cycles of the Aztecs and Guatemalan tribes but have never been able to eradicate a one-day fault in the evidence between these and the tzolkin of the Mayas in Yucatan. Whether this one-day fault should be eradicated arbitrarily is another matter.

The correlation between Aztec and European dates reached by me at that time proved to be identical with the one previously announced by Eduard de Jonghe[1] and accepted by Beuchat[2] in his *Manual of American Archeology*. Seler[3] had contributed to the ultimate determination of the

[1] 1906.
[2] 1912; pp. 331-342.
[3] 1893; also Gesam. Abh. I, pp. 172-182, and Bull. 28, pp. 135-144.

Aztec-European correlation by his proofs that the Mexican year-bearers were the initial days of the month Toxcatl. None of these writers, however, suspected a temporal conformity within the total distribution of the Central American calendar system[1].

Full and consistent material for correlation exists in Guatemalan documents. In a Quiché almanac of 1685 there is also a statement concerning the recession of the year of the Indians in the European year, which I quote:

> Because neither the Mexicans nor these tribes understood leap year day . . . they drew apart and became different from our calendar, and . . . each four years they lost a day; that is, in the years 1681, '82, '83, and '84 the year of the Indians of this kingdom commences on the first of February and that of '85 will commence on the thirty-first of January and that of 1805 will commence on the first of January, and four years hence on the thirty-first of December, etc.

There are a considerable number of double dates in the Annals of the Cakchiquels[2] as well as the confronted almanacs of 1685 (quoted above) and of 1722 which are in entire conformity[3].

More recently the 260-day cycle has been found in operation among the Quiché, Mam, Jacalteca and Zutugil tribes by Blom, La Farge, Byers and Lothrop. The months seem to have dropped out of use but among the Jacalteca the year-bearers are still noted. Lothrop gives the comparison for March 28 to April 16, 1928, beginning with 8 Vats (8 Chuen in the Maya usage of Yucatan) and ending with 1 Tzic (1 0c). Under Correlation A, March 28, 1928, reduces to 13- 8-17-11-10, 7 0c 18 Kayab, the day before 8 Chuen 19 Kayab. The one day discrepancy found here holds true of the older Mexican and Guatemalan dates when compared with those of Yucatan.

An error of a day is easily made but I prefer to think that no such error crept into Landa's typical year. He writes 12 Kan as the equivalent of July 16, 1553 as has been said and says in another place that the Maya year began then. It is true that if we bring the calendars of Guatemala and Mexico to focus on this date we get the next designation of the tzolkin, namely, 13 Chicchan on July 16 or vice-versa we get 12 Kan on July 15. On the theory that the ancient Maya day began at sunset—as the modern one does among the Quiché according to reliable information—such an error is explainable. That is, a person taking down information in the evening might obtain the new day name instead of the old one that had coincided with the daylight hours just passed.

There remains the possibility of a true difference of one day between the calendars of the Mayas on the one hand and the Mexicans and Guatemalan tribes on the other. Eric Thompson rather begs the issue using an

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[1] It was admitted that the 20-day names had a similar etymology. Seler accredited the invention of the 260-day cycle to the Zapotecs but in this he was surely mistaken.
[2] Spinden, 1924, pp. 103-107.
[3] For the Annals of the Cakchiquels, see Brinton, 1885. The almanacs have been photographed by Gates and may be consulted in the Bowditch Collection in the Peabody Museum of Harvard University.

equation number which puts 12 Kan in 1553 on July 15 instead of July 16, the place actually recorded in Landa's typical year.

One lot of evidence in the Mexican source material strongly supports Landa in that it requires a one-day shift between the Maya tzolkin and the Mexican tonalamatl. This is the evidence touching the introduction of the calendar into Mexico by Quetzalcoatl. He is given credit or having established the year count on the highlands of Mexico, for having introduced a ceremony at intervals of 52 years concerned with the making of new fire, and also for having calculated a rising of Venus as morning star in conformity with ancient essentials[1].

The year-bearer 1 Tecpatl, distinguishes the first year of the Mexican annals. It was obviously the first day of the month Toxcatl. Conformity with the Maya usage is found at:

1 Tecpatl 1 Toxcatl=11-10- 6-16-17, 13 Caban 5 Muan,
August 6, 1168 A.D.

Now 1 Tecpatl is etymologically equivalent to 1 Eb the day after 13 Caban in the above statement. But the one day jog permits the Toltec year of Quetzalcoatl to begin on August 6, the true anniversary of 7- 0- 0- 0, 10 Ahau 18 Zac, August 6, 613 B.C., Gregorian calendar, which was the epoch of the Historical Era of the Mayas.

The evidence on the New Fire Ceremony is in exact agreement with the above. The ceremony is placed on a day 7 Acatl and in a year 2 Acatl corresponding to 1195-96. It reduces to 7 Acatl 1 Panquetzaliztli =11-11-14-15-12, 6 Eb 0 Yaxkin, Feb. 16, 1196 A.D. Here 0 Yaxkin is the ancient beginning of the agricultural year of the Mayas. In Yucatan special ceremonies leading up to the month Yaxkin are described by Landa as being practiced by the party to which Quetzalcoatl had belonged and as involving the making of fire and the display of gorgeous feather banners. The Aztec month name means "feather banners." Again 7 Acatl must be made the equivalent of 6 Eb instead of 7 Ben with which it etymologically coincides.

The third event, the apotheosis of Quetzalcoatl, is a day 1 Acatl in a year 1 Acatl when the soul of the Toltec warrior passed into the morning star. The Mexican year 1 Acatl was 1207-08 and the second day 1 Acatl in this year (the first one having been the year-bearer) was 1 Acatl 1 Itzcalli. This, with the one day jog is 11-12- 7- 3-12, 13 Eb 0 Yax, April 13, 1208 A.D., heliacal rising of Venus 4 days after inferior conjunction with the sun. This date is in complete agreement with the Venus Table of the Dresden Codex under the regent 1 Ahau 13 Mac. These three specific interrelations of the Maya and Aztec records are fundamental and all imply that a one-day shift in the 260-day cycle had really taken place.

[1] See Spinden, 1928, pp. 55-59.

All the important evidence in post-Spanish sources bearing upon our problem of correlation now lies before us. By strict application of the controlling facts Correlation A reduces to the equation 489384, this being the number which will unite identical days in the Maya and Julian day counts when added to the former or subtracted from the latter. Correlations B and C, both unlikely but still retained for experimental purposes, call for the addition or subtraction of 94900 from the equation of Correlation A. For Correlation B the equation is 584284 and for Correlation C it is 394484.

Historical Survey of Maya Correlations. We have already seen that Bishop Landa did not understand the method by which the Mayas recorded historical facts in a chronological pattern and that Avendaño writing in 1696 was the first to exhibit a good grasp of the subject although he made the mistake of counting the katuns at exactly twenty years apiece. Unknown writers of marginal comments in the Books of Chilam Balam come to about the same conclusion[1]. There is a tradition concerning a conference of Indians in the Bacalar region called for the purpose of working out a computation in the double terms of the Maya and European calendar. If they devised the almanac now found in the Books of Chilam Balam and already discussed above their work was not well done. Perhaps, however, they merely tried to set in order the series of prophecies of the katuns.

Juan Pio Perez, writing in 1843, was ignorant of the fact that katuns are 7200 days long.[2] He constructed an erroneous value of 24 years (8760 days). He translated the Chronicle of Mani and tried to use the death of Napot Xiu for purposes of correlation. His real base was, however, a Katun 8 Ahau, second day of a year 7 Cauac which corresponded to 1392.

Brasseur de Bourbourg in his *History of the Civilized Nations of Mexico and Central America* reached a surprisingly accurate point of departure for the Chronicle of Mani by an undisclosed method. He writes[3] "Maya chronology fixes the year 174 of the Christian Era for the departure of the four Tutul Xius." In Correlation A the epoch of the Era of the Chronicles is 9- 0- 0- 0- 0, 8 Ahau 13 Ceh, which corresponds to February 10, 176 A.D. in our present calendar. Unfortunately, Brasseur de Bourbourg's remarkable early work was eclipsed by the fantasies of his later writings.

Valentini in 1880 arranged the katuns of the Chronicle of Mani in the way they now are accepted. He used 1542 as a point of departure and counting back 70 katuns of 20 years each reached 142 A.D. for the zero of the count.

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[1] In the Chumayel MS (p. 53 et seq.) there are a series of katun-heads: the year 1560 is written beside 9 Ahau and the subsequent katuns are at 20 year intervals.

[2] In the Books of Chilam Balam there are statements concerning the sequence of Ahaus at the end of uinals, tuns and katuns which could have been used to reach 7,200 days for the katun. The value was solved first in the inscriptions.

[3] 1857-59, II, p. 3.

Thomas in 1882 made a variation on the Pio Perez scheme and reached a result which has no merit. In the same year Brinton published the text of all five Maya Chronicles. He rather favored the katun at 20 years but as a matter of fact wavered under pressure. In one place he writes: "The total period of time, from the earliest date given to the settlement of the Spaniards as 71 katuns. If the katun is estimated at twenty years this equals 1420 years; if at 24 years, then we have 1704 years." By wrongly taking July 15, 1541 for the last day of Katun 11 Ahau he reached 121 A.D. by one measure and 173 B.C. by the other.

In 1895 Seler adopted the correct value of 7200 days for the katuns of the Chronicles but unfortunately made an erroneous adjustment to the Long Count. He used a statement in the Mani and Tizimin MSS which placed Katun 5 Ahau on 5 Ahau 18 Tzec in 1594. Although publishing a series of katun endings on this contact he failed to develop the full implications of the arrangement and certainly did not believe in the great antiquity which it would give the dates on First Empire monuments. Förstmann's suggestions in comparative chronology do not rank with his other work while Lehmann's table of 1921 is archeological.

The first attempt at what might be called a day-for-day correlation of the Long Count of the Mayas and European chronology was made by Bowditch in 1901 in his *Memoranda on the Maya Calendars used in the Books of Chilam Balam.* By manipulating references to Napot Xiu, Bowditch reached the position 13- 2-13- 3- 1, 9 Imix 19 Zip, in the Long Count of the Mayas for a date in the autumn of 1536. He soon dropped this arrangement as indefensible but Joyce took it over in 1914 in a chronological table and in 1925 Long converted this discarded correlation of Bowditch into a precise form:

13- 2-13- 3- 1, 9 Imix 19 Zip=September 11, 1536, O.S.

Except for the error of identifying the Maya year 4 Kan with 1536 instead of 1545, this correlation would coincide with the basic possibility labeled C.

Goodman in 1905 suggested that several time counts operated in Yucatan at one and the same time, specifying one used by the Xius and another one by the Itzas, Cocoms and Chels. The Xiu calendar he defined by the following arrangement which will be recognized as that of Correlation B:

11-16- 0- 0- 0, 13 Ahau 8 Xul, October 30, 1539 O.S.

This gives the equation 584280. By a strange lapse of logic Goodman accepted the July 16, O.S. of Landa as an absolute date for the Maya year-bearer[1] whereas the date applies only to 1552-1555 A.D. and relative to 1539 allowance should be made for the leap year intercalations of 1540,

[1] He says: "July 16, 1526, was the Yucatan day 11 Muluc and July 16, 1541, 13 Kan." The interval is 15 x 365 days which obviously cannot produce July 16 in the Julian Calendar at both ends.

'44, '48, and '52 which should have induced him to declare for July 20 at the stated place.

The Goodman Correlation still finds supporters. Martinez by a somewhat different argument from the defective almanac of the Books of Chilam Balam reaches July 19 O.S. or the equation 584281 for the same position in the Long Count while Eric Thompson finds the specific equation 584285, seeking exact conformity with the Mexican and Guatemalan usage. Strict application of Landa's typical year, however, gives 584284. The thesis of Martinez and Thompson, in which Teeple has recently joined, finds support in Page 66 of the Chronicle of Oxkutzcab already examined.

In 1910 Morley effected an arrangement between the katuns of the Maya Chronicles and the katuns recorded on the ancient monuments. He placed the Initial Series date at Chichen Itza in the earliest occupation of this site according to the Chronicles, and thereby reached 9- 0- 0- 0- 0-, 8 Ahau 13 Ceh, for the zero of the katun sequence in the Maya Chronicles. Until 1918 Morley applied his European dates to the wrong end of the katun thereby causing an historical displacement of about 20 years. In 1920 by a process of delimiting references to the katuns in the Spanish period Morley believed he had placed Maya dates within 46 days of an exact correlation but actually the deviation was nearer 250 days. The important point is that his calculations[1] led to Correlation A but without a day-for-day adjustment. It is to his credit that he discovered and published Page 66 of the Chronicle of Oxkutzcab while rejecting its implications. He despaired of a day-for-day correlation of Maya and European chronology on the broken evidence although admitting:[2]

> If it were possible to establish a single point of contact between the two, every date in Maya chronology could be transcribed into the corresponding Julian or Gregorian equivalent, and the dates on the Maya monuments would suddenly become more accurately fixed in our chronology than any event of Old World history prior to the birth of Christ, and this solely because of the extraordinarily exact character of the native Maya chronological system, which within itself is absolutely accurate.

Next in order I consider my own work in matters of correlation. It began with a table published in 1910 for distribution at the Congress of Americanists meeting in Mexico City. In this table the sculptural and architectural art of Copan is arranged in stylistic sequence which follows

[1] One of Morley's arguments concerned a number of dates in Chichen Itza and Uxmal which, if transcribed under Correlation B instead of A, would become post-Spanish. Morley's readings are probably correct but doubt has been expressed whether 18 tuns instead of 18 Xul is not registered in the inscription of the High Priest's Grave at Chichen Itza. As 11-19-11- 0- 0, 2 Ahau 18 Xul, Dec. 31, 1349 A. D. under Correlation A, this would reach the year 1609 under Correlation B. If read 2 Ahau, Tun 18; 2 Ahau, Tun 11, there would be two dates, namely,

11-18-18- 0- 0, 2 Ahau 3 Yax, Mar. 16, 1337 A. D.
13- 0- 0
11-19-11- 0- 0, 2 Ahau 18 Xul, Dec. 31, 1349

But both of these might recur in the Long Count at thirteen katun intervals. The reading on the tablet in the Nunnery at Uxmal is justified by the original although this is in poor condition. I examined the text carefully in 1930. Here 5 Imix 19 Kankin is recorded as in a Tun 18 of a Katun 13. This combination yields 11-12-17-11- 1, 5 Imix 19 Kankin, July 19, 1218 A. D., which would pass into 1478 under Correlation B. The inscription on the Ball Rings at Uxmal is probably correctly deciphered as 11-15-16-12-14, 10 Ix 17 Pop, Oct. 15, 1276, which would be pushed forward to the year 1536 under B.

[2] 1920, pp. 465-466.

the same order as the inscribed dates. As a result of this demonstration it became possible to place calendar round dates in their most probable locations. In 1913 I published as Table 2 of my *Maya Art* a general correlation of the dates in the monuments and in the Chronicles making the basic adjustment suggested by Morley with zero of the Chronicles corresponding to 9- 0- 0- 0- 0, 8 Ahau 13 Ceh, of the Long Count. Katun 11 Ahau of the Conquest was correlated with 1541 in accordance with Landa's erroneous statement to that effect. This placed Baktun 9 on 160 A.D. whereas Morley made it 155 A.D. Both of us made the mistake of thinking that katuns were named after their initial rather than their terminal days.

At the very end of 1919 I announced a day-for-day correlation between Maya and European chronology resting upon Landa's typical year, or almanac, which was then for the first time ascribed to 1553 on the basis of 12 Kan as year-bearer. The Long Count statement of Landa's year-bearer became 12- 9-17- 9- 4, 12 Kan 2 Pop, July 16, 1553 Julian Calendar or July 26 Gregorian Calendar. The supporting proof offered was that under this arrangement the days and months of the Aztecs coincided with those of the Mayas. At that time I wrote:

"This initial day 6 Kan 1 Pop of the Maya year 6 Kan fell on August 3, 1521, and the Aztec year 3 Calli found a practical equivalent in the first day of the month Tlaxochimaco that began with 5 Calli on August 1. More exactly 6 Kan equals 6 Cuetzpalin, the second day of the Aztec month Tlaxochimaco, corresponding to August 2. We find, therefore, that the permutation cycles of the two calendars come within a day of exactly coinciding."

It was not until 1924 that I was able to follow up the possibilities of this correlation by preparing tables for the ready conversion of Maya dates into their European equivalents. In my *Reduction of Maya Dates* I explained a considerable number of other proofs and interesting circumstances. In the first place a beginning was found for the Maya historical record in the seventh century before Christ. This epoch was reached by calculating the recession of a 365-day year in the natural year of the seasons in connection with the etymologies of Maya month names and the symbolism of the month hieroglyphs. By this means 0 Pop, the Maya New Year, was placed on the winter solstice about 580 B.C. and the months Xul and Yaxkin, meaning "end" and "green sun" respectively were placed at the end of the dry season and the start of a new agricultural year. By the same arrangement the month glyphs founded on the symbol Cauac meaning rain were shown to coincide with the rainy season. This epoch fell close to 7- 0- 0- 0- 0, 10 Ahau 18 Zac, in the Long Count and it soon became apparent that this Baktun 7 was really the epoch of the Historical Era.

A further tie between the Chronicles and the inscriptional record was developed on references to the "setting of Pop in order" in a katun which

corresponded to the terminal date on Altar U at Copan where two 0 Pop dates were recorded. On this monument also occurred a much repeated 6 Caban 10 Mol which obviously had been on the agenda of an important conference at Copan. These dates were converted into April 9 for 0 Pop and September 2 for 10 Mol. In these positions the dates coincided with the sunset readings made along a line marked by two famous hilltop monuments at Copan according to the angle determined by the Carnegie Institution, and the report thereon by an astronomer, Robert W. Willson of Harvard University[1]. At the same time other dates recorded on one of the terminal monuments and elsewhere, showed that an earlier pair of readings had reached April 5 and September 6. Also there were indications that still a third pair of reciprocal readings, namely, April 12 and August 30 might have had significance. The explanation given was that these vernal and autumnal "stations" were important in connection with two times of the year when maize was planted.

Other dates in the Maya inscriptional record were found to reach the solstices and the equinoxes. In connection with equinoctial dates special ideographic symbols were found which had an obvious symbolism in reference to the equable division of day and night. It was shown that the Mayas could handle the tropical year with marvelous accuracy in relation to fixed points of departure using 29 calendar rounds, equal to 550420 days, as the value of 1508 calendar years or 1507 tropical years. It was also shown that the Mayas were accustomed to restate in terms of the natural year the places occupied by the epoch of the Mundane Era (October 14) the epoch of the Historical Era (August 6), etc.

But much of the expected astronomical support did not at once appear. For one thing the dates in connection with the Venus and Lunar Tables in the Dresden Codex did not strike heliacal risings and eclipses. It was not until the end of 1926 that the *modus operandi* of an uncorrected use of data on Venus was announced. In 1928 I published findings on this Venus Calendar including a considerable number of ancient records where well known hieroglyphs of the planet occur in connection with dates on which heliacal risings took place. At the same time the barrier of the Lunar Calendar was breached and I was able to express the opinion that the lunar count of the Mayas was also of a vague type comparable to the Venus Calendar and the uncorrected vague year of the Civil Calendar. At the same time important interlockings of Maya and Mexican time counts in connection with Venus and the New Fire ceremony were spread upon the record.

Families of Astronomical Correlation. Several correlations, based on interpretations of astronomical matter in the Maya inscriptions and the Dresden Codex were suggested by Willson (1924) and Teeple (1927).

[1] Recently a second reading of this angle was made under adverse conditions due to dense smoke. The observers of the Carnegie Institution shifted their previous reading to April 12.

Both these investigators pursued their manipulations of dates and numbers unhampered by any sense of obligation to the facts revealed in documents of the Spanish Conquest. The investigations of the late Robert W. Willson, Professor of Astronomy at Harvard University, were especially careful and painstaking, extending over many years and involving the preparation of tables for Venus, Mars, the moon, etc., and the invention of laboratory apparatus for the testing of eclipse coincidences. Teeple approached the astronomical problem as a mathematical puzzle or a mysterious code written in numbers. His solution of the Supplementary Series of the Maya inscriptions, was a most important demonstration.

Willson was able to find a possible coincidence of seven or perhaps eight visible eclipses out of ten when manipulating freely his "eclipse strip" marked with the intervals between pictures in the Lunar Table of the Dresden Codex. He abandoned hope of solving Maya chronology from the lunar evidence alone and brought the matter of Venus into a complex with that of the moon and even tried to allocate data on Mars. He assumed that the Maya date 9- 9- 9-16- 0, 1 Ahau 18 Kayab, marked an heliacal rising of Venus four days after inferior conjunction and that 9-16- 4-10- 8, 12 Lamat 1 Muan, was a solar eclipse date. These two chronological positions are prominently recorded in the Dresden Codex in connection with the Venus Table and the Lunar Table respectively. While the assumptions of Willson were logical on *a priori* grounds, they were not, strictly speaking, imposed by all the evidence. As regards possible locations of these dates in European chronology Willson developed the interesting fact that at intervals of 48492 days (6-14-12-12) Venus can be placed at heliacal rising and the moon at a possible solar eclipse. Willson's favorite correlation on the astronomical evidence established 9-12- 4-10- 8, 12 Lamat 1 Muan, on October 29, 357 A.D. but he declared that July 15, 223 A.D. and February 14, 492 A.D., all in the Julian Calendar, agreed rather closely with the requirements. These correspond to equations of 438906, 389856 and 487956 respectively, between Maya and Julian day numbers. Actually Willson considered twenty-five or more places where the postulates are met more or less exactly, these places being separated by the interval of 48492 days.

In an article entitled *Maya Inscriptions: the Venus Calendar and Another Correlation,* Teeple expressed the opinion that the same Maya date treated above, namely, 9-16- 4-10- 8, 12 Lamat 1 Muan, was November 22, 504 A.D. in the Julian Calendar, or possibly one of the following: December 14, 46 B.C., June 6, 327 A.D., January 26, 548 A.D., May 16, 877 A.D. or January 5, 1098 A. D. Actually all of these suggestions are widely out of agreement with the Maya time count as it was operating in the sixteenth century. Yet Teeple himself says: "If we disregard the calendar of early Spanish times, as we are attempting to do here, and use the broad limits outlined . . . then these dates under discussion only become a particular six out of many that might be named."

Correlation by astronomical postulates has no large factor of safety under the methods of Willson and Teeple. The Maya time machine is arbitrarily adjusted first to an eclipse syzygy at one date and secondly to an heliacal rising of Venus at another date. The fact that Willson and Teeple do not make exactly the same postulates on the same subject matter may be taken to mean that a third person might introduce another difference and thereby make possible a third family of correlations. It is a conspicuous and perhaps disappointing fact that investigators relying on the arbitrary interpretation of astronomical matter in the inscriptions and codices have not found conformity with the historical matter nor have they developed further coincidences than existed in the postulations. Neither Willson nor Teeple tested the logical possibility of formal or uncorrected calendars.

The Supplementary Series of glyphs following Initial Series was first studied by Goodman, Bowditch and Morley. Goodman reached the conclusion in 1905 that "it was a computation by single days to 180 originally, but later to 200." The brunt of arrangement and classification of the glyphs was done by Morley. Teeple succeeded in working out the way in which Glyphs D and E were combined to give an age for the moon, that is, the serial day of a lunation; while glyph C stated a number of complete lunations never exceeding six. In some cases where we have 6 C in combination with a positive record of added days, the former must be regarded as a "full" zero. At any rate, Teeple greatly overstates his proofs when he says: "We have demonstrated, then, that E and D give the age of the moon counting from new moon, that it is an observational record and that it may be relied upon to give the exact position of the moon at any date with an error of observation not exceeding 2 or 3 days." In my opinion what Teeple really demonstrated was that the ED combination gives either the true or the calendarial age of the moon counting from a natural phase which might be either new or full moon.

The Origin of the Maya Tzolkin. An astronomer's explanation of the origin of the Maya tzolkin is now offered by Ludendorff, director of the Astrophysical Observatory at Potsdam. This permutation of 20 names and 13 numbers hitherto has been called an arbitrary invention. Ludendorff now says that the cycle had its origin in the mathematical analysis and plotting of eclipse data.

He assumes that Correlation A is correct and that the epoch of the Historical Era of the Mayas is actually the date 7- 0- 0- 0- 0, 10 Ahau 18 Zac, August 6, 613 B.C., or, in astronomical terms, Julian day 1497384. He notes that a double tzolkin (2x260=520 days) is practically equal to three eclipse seasons, a matter already observed by Maya students. He goes much further than this, however, by demonstrating that for a century or more before the definite formulation of the Maya Long Count the day 1 Imix was the focus of an important series of lunar and solar

eclipses. Now this day 1 Imix is recognized everywhere as precisely the first day of the Maya tzolkin pattern. Two other mean days of eclipses in terms of the tzolkin were located about 173 and 346 days, respectively, after 1 Imix, or on 5 Ix and 10 Lamat. But the stress really fell on the nearby days 2 Chuen and 6 Kan. Since 520 days are a little in excess of 3 x 173.31 days the mean points of eclipses recede slowly in the tzolkin pattern. While 1 Imix did not coincide exactly with an eclipse mean at the inauguration of the Long Count on August 6, 613 B.C., the error was so small as to be negligible.

Of course, the Mayas could not observe the double tzolkin as an actual interval between two eclipses. They had to reach this value in an averaging process over a considerable time. About the best they could do was to catch occasional intervals of 502-3 days or 531-2 days between visible eclipses of the moon. Or they might catch 2598 or 2599 days, nearly five times the double tzolkin. The first true multiple would be found at 4680 days (which is 13 x 360 as well as 9 x 520), this being an interval between one eclipse of the sun and another of the moon. At 11960 days eclipses of the same orb might return on the 23rd double tzolkin. This number is the basis of the so-called Lunar Calendar of the Mayas.

Ludendorff does not enter into any detailed explanation of how the shorter cycle of 260 days might have been reached as half of a mean construction involving the interrelation of lunations and eclipse seasons. Perhaps a word or two on this matter may prove of interest. From other indications we may assume that the Mayas kept their early celestial records in string archives, using ordinary beads for common days, shells for lunations, special jade beads for years, etc. Also we may assume that the words for numbers were constructed on the vigesimal base. This means that the method of counting was developed by using the fingers of both hands and the toes of both feet before entire "men" were used as a second degree of value[1]. These assumptions are supported by the etymologies of calendarial and numerical names and by the symbolism fixed in the hieroglyphic writing which must have emerged from folk practices. We know that ultimately the true lunations was reduced to a mathematical unit of 20 days because the name for the second degree in the special numerical notation of days is uinal, obviously derived from u, moon, and because the moon symbol has the value 20 in certain situations. A year of approximately 12 lunations was reduced to a mathematical construction of 18 x 20=360 days, called tun which means stone or more likely jade bead. We begin, then, with 20 as an antecedent factor of the tzolkin.

With their variegated string archives hung up before them we may imagine the astronomer priests among the ancient Mayas sitting down to manipulate the fates. Now there are common procedures in games of chance, magical formulæ and astrological lay-outs the world over. Using

[1] The name for 20 in some Maya languages is precisely *winak* which means "man."

conventional counters, much as we use playing cards, primitive seers and savants are accustomed to deal and redeal the elements of fate—which in the case of the Mayas were eclipses and other celestial phenomena recorded in an ephemeris—always seeking patterns of striking simplicity. Men on the verge of civilization are singularly taken in by mechanical lay-outs on a permutation or other numerical basis: they recognize magic in numbers.

We possess several ceremonial patterns of the Mayas. One is a sign for completion or full zero occurring in the ancient inscriptions which has

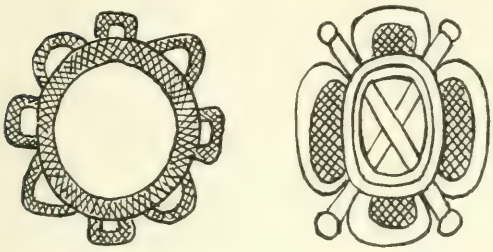
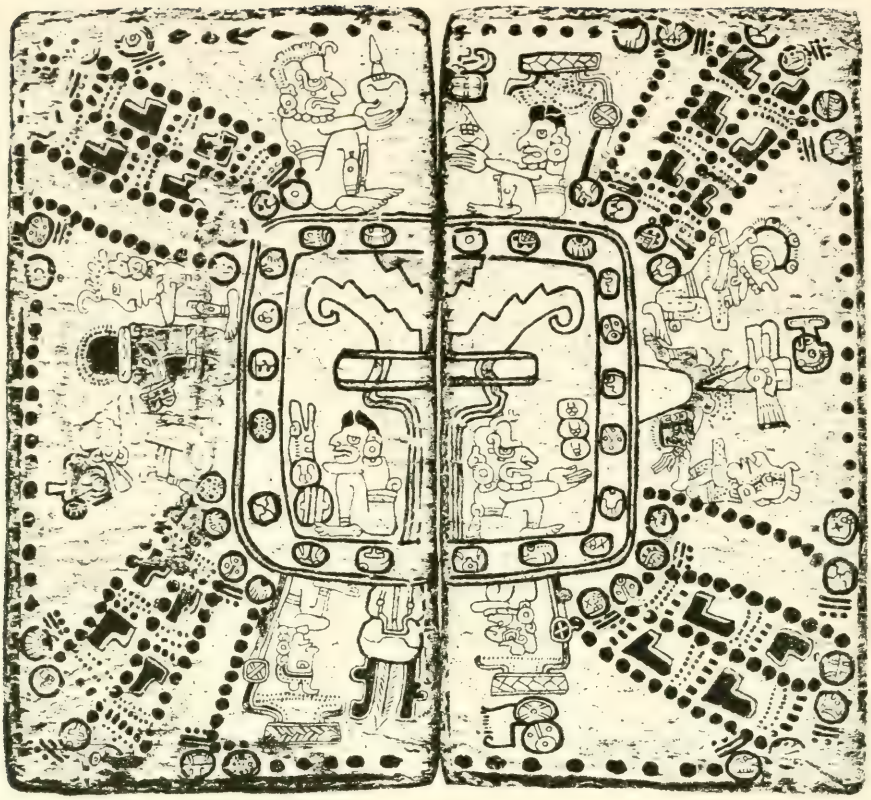


Fig. 5. *a*, Symbol of the universe on a birch bark record of the Ojibwa Indians; *b*, A Maya symbol of universality and the zero of completion.

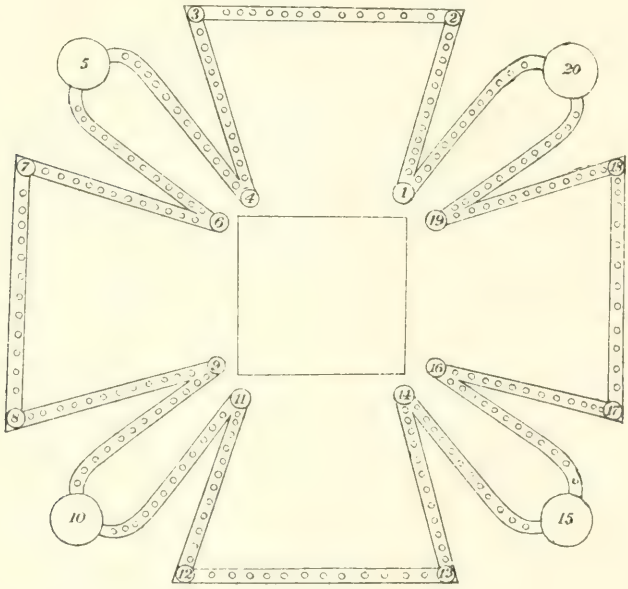
all the features of a developed cosmic symbol. I compare it with the universe as portrayed on birch bark records of Indians of the Lake Superior region (Figure 5, a and b). In the Maya codex called the Tro-Cortesianus the days of the tzolkin are distributed on an enlargement of this pattern, as also in the Mexican codex called Fejérváry-Mayer (Plate 1a and b). The figure has four wide lobes at the sides, one for each world quarter, and four narrow lobes at the corners. All in all twenty courses are formed each holding thirteen days, so that a place is given to each day of the tzolkin. Also there is an inner band with places for the twenty-day signs without coefficients. Imix is found in the northwest corner, and the other days are then dealt out to the left with Ik on the south, Akbal on the east, Kan on the north, Chicchan on the west beyond Imix, etc. Diagonally opposite this day sign Imix we find 1 Imix in the inner angle formed by the eastern and southeastern lobes. 1 Ik, thirteen days distant, is on the outer southeastern corner of the east lobe; 1 Manik, another thirteen days away, is at the outer northeastern corner, and so on around the figure.

In similar fashion astronomer priests of the seventh century before Christ might have counted out the numbers of days found as intervals between eclipses, culminating in 11960. Perhaps their pattern was merely a square or circle in connection with which the days were distributed in twenties. Even if the Mayas reached 520 as the eclipse cycle by this method, they would soon find that the pattern could be reduced to half



Tro-Cortesianus

A. Counting-out pattern of the Tro-Cortesianus Codex.



B. Structure of the counting-out pattern of the Fejérváry-Mayer Codex. The Maya count begins on 1 Imix in the position marked 11 on the Mexican pattern.

that sum of days by a simple overlapping. That is, if the first circle covered 520 places, displaying 20 names in sequence, eclipse nodes would be found at A, B, and C. A second circle of 260 places with nodes at A, C, and B would reach the same day names and be more attractive because more compact and recondite. The only difference would be that two turns of the diagram completed the overcycle.

In Table 2 of his article Ludendorff lists 78 eclipses of the sun and 73 eclipses of the moon between 748 B.C. and 614 B.C., all but four (and these invisible) being within fifteen days of 1 Imix. Only eight of these

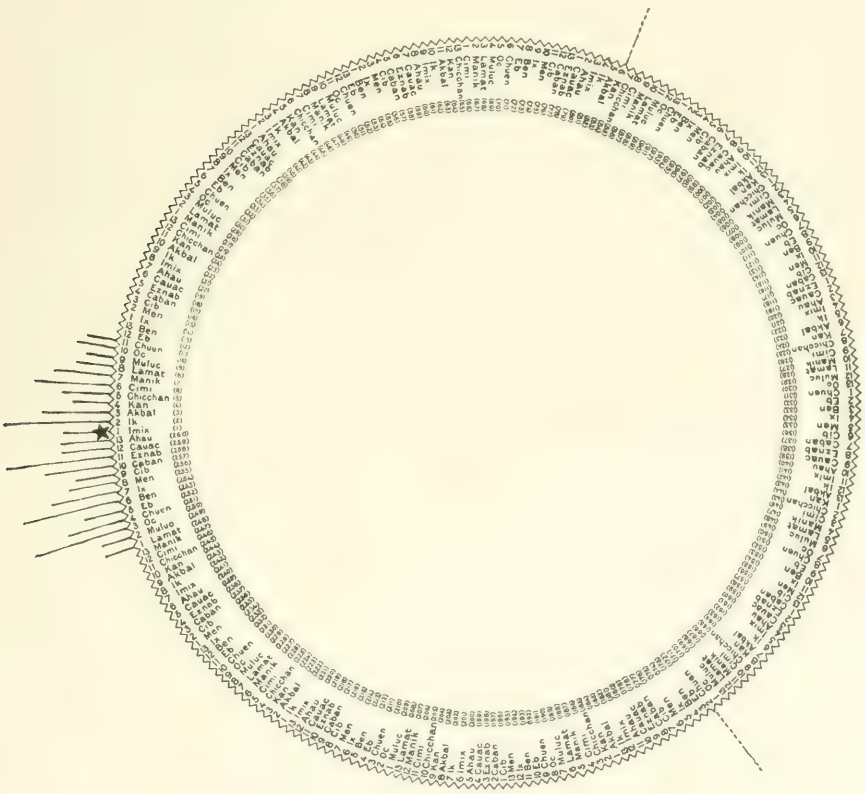


Fig. 6. Tzolkin wheel of 260 days with distribution of eclipses about 1 Imix. The longest lines are eleven eclipses on 11 Eznab and 2 Ik.

eclipses of the sun were visible in Maya territory, however, the proportion of visible eclipses of the moon being several times greater. It seems that the tzolkin pattern must have been developed very largely on lunar eclipses. I give the distribution of all the eclipses in Ludendorff's table (except the four above 15 days from 1 Imix) in Figure 6 formed on the tzolkin wheel and indicate the places of two other groups. Ludendorff does not develop fully the record on the second and third foci.

With this account of a new demonstration in favor of Correlation A I close the section on preliminary evidence as regards the proper method of transcribing Maya dates into our own chronology. I eliminate Correlation C from further consideration but retain Correlation B for the time being. It must be held in mind that the tzolkin day is the same in each system, since 12 Kan on July 15 O.S. occurs at intervals of 260 days in past or future. The difference between the two arrangements appears in two things: dates fixed in the Maya record are moved forward 94900 days (260 x 365 days) in European chronology when B is substituted for A and dates fixed in European chronology are moved backward by the same amount. That is

. 9– 0– 0– 0– 0, 8 Ahau 13 Ceh { Correlation A, Feb. 10, 176 A.D. (Greg. Cal.)
Correlation B, Dec. 10, 435 A.D. (Greg. Cal.)

Since the Maya year is a vague one, the distortion in the tropical year amounts to about 62 days between the two correlations. Dates that strike the solstices or equinoxes under Correlation A will not repeat these coincidences under Correlation B. Vice-versa, a position in European chronology passes through the following transformation:

J.D. 1, 785,384 (Feb. 10, 176 A.D. Greg. Cal.) { Correlation A
9– 0– 0– 0– 0, 8 Ahau 13 Ceh
Correlation B
8– 6–16– 7– 0, 8 Ahau 13 Ceh

Lunar Calculations of the Mayas

A new section of our survey, devoted to the way in which the Mayas handled data on the moon, begins at this point. Eclipses both of the sun and of the moon are effected by the same celestial mechanism. I need only repeat in the briefest fashion a few of the elements in the eclipse problem which reacted upon the Mayas. The phenomena occur when the sun, the moon and the earth are most nearly in line. The conditions are controlled principally by the fact that syzygies (a term applied to the times when there is a lining up of the orbs, or, let us say, at the moments of new moon and full moon) only become eclipse syzygies when near one of the moon's nodes. The points of these nodes are found at a mean distance of 173.31 days from each other. The Mayas, as Ludendorff has shown, constructed their tzolkin on the basis of $3 \times 173.31 = 2 \times 260$. Two eclipse seasons are 346.62 days which is 18.63 days less than a year. In other words, the mean points of eclipse seasons (round which eclipses fall on moments of new moon for those of the sun and of full moon for those of the moon) have a retrograde motion in the tropical year which requires 18 or 19 of the latter for a complete turn. We must imagine the Maya conception as one in which the double tzolkin is divided into thirds which represent eclipse seasons. The whole period of 520 days then retrogrades through the successive tuns of 360 days and vague years of 365 days as well as through the true year of the seasons.

Mechanisms of the Maya Count Applied to Lunar Data. Ludendorff's explanation of the origin of the Maya tzolkin out of eclipse data collected in the eighth and seventh centuries before Christ develops only one of the mechanical correspondences which exist between the structural units of the Maya chronological system, on the one hand, and multiples of the lunation period and the eclipse season on the other hand. It holds true only under the terms of Correlation A and therefore stands as an interesting proof of the correctness of that arrangement.

Before delving into the matter of historical places of eclipses, I wish to put on record certain proximations which might have served the Maya astronomers as rules of thumb. The eclipse season is not in itself apparent and, while the lunation can be observed easily enough, it runs into a fraction of a day that is exceedingly hard to handle. It follows, therefore, that easily remembered time units restoring lunar phases and eclipse syzygies become tools for calculation. I begin with correspondences between tzolkins and lunations.

Tzolkins and Lunations

	Tzolkins	Days	Lunations	Days	Difference
A	5	1300	44	1299.32	—.68
B	41	10660	361	10660.55	+.55
C	46	11960	405	11959.89	—.11

Although eclipses of the same orb must recur on true multiples of the lunation (and otherwise on the half lunation) it is also necessary that a multiple of the eclipse season be close at hand. Practically, for low numbers, this means a multiple of the double tzolkin. If interval A is doubled, we obtain such a condition since 10 tzolkins are 2600 days and 88 lunations are only 1.31 days less than this amount. Interval C is that of the Maya lunar calendar which is highly effective as an eclipse interval.

Next we consider lunations and round numbers, without for the moment seeking those that can be used to recover eclipses. The third degree of value is the tun of 360 days and 12 lunations are 354.37 days or 5.63 days less than this sum. The hotun finds a much closer adjustment in that 1800 days are only 1.37 days less than 61 lunations. In the case of the katun the error is, therefore, about the same as that of the tun but on the opposite side of the ledger: 21 tuns recover a close conformity on phases of the moon, amounting to 7560 days while 256 lunations are 7559.83 days. The Mayas did not pay much attention to this interval seeking instead such multiples of the hotun as the following:

MULTIPLES OF HOTUNS AND LUNATIONS

	Hotuns		Days	Lunations	Days	Difference
D	22	(5–10– 0– 0)	39600	1341	39600.52	+.52
E	43	(10–15– 0– 0)	77400	2621	77399.67	—.33
F	173	(2– 3– 5– 0– 0)	311400	10545	311400.06	+.06

Round numbers that recover eclipse syzygies are a different matter. Here the manipulation depends largely on the value of 13 tuns which is also important in Venus calculations as we shall see elsewhere. The single interval may lead from an eclipse of one orb to one of the other orb. Taken twice with one lunation added, syzygies of the same type are recovered.

THIRTEEN TUNS AS AN ECLIPSE INTERVAL

G	13 tuns (13– 0– 0)	= 4680	days	
	27 eclipse seasons	= 4679.35	"	— .65
	158 lunations	= 4665.83	"	—14.17
H	26 tuns (1– 6– 0– 0)	= 9360	days	
	54 eclipse seasons	= 9358.69	"	— 1.31
	317 lunations	= 9361.20	"	+ 1.20

Conformity with eclipse requirements exists also for 194 tuns which by the addition of twice interval A (2 x 1300=2600 days) passes into an accurate and highly important eclipse number amounting to exactly 11 katuns. This was employed by the Mayas at Copan and elsewhere.

I	194 tuns (9–14– 0– 0)	69840	days	
	403 eclipse seasons	69843.61	"	+3.61 days
	2365 lunations	69839.84	"	— .16 "
J	11 katuns (11– 0– 0– 0)	79200	days	
	457 eclipse seasons	79202.02	"	+2.02 "
	2682 lunations	79201.04	"	+1.04 "

The vague year of the Mayas is comparable to the sacred year of the Egyptians as regards length but not as regards its internal construction since it consisted of 18 x 20 + 5 days instead of 12 x 30 + 5 days. Among the correspondences between years of this type and lunations we find two arrangements which the Mayas seem to have known:

VAGUE YEARS AND LUNATIONS

	Years	Days	Lunations	Days	Difference
K	8	2920	99	2923.53	+3.53
L	25	9125	309	9124.95	— .05

It will be noted that K is the short round of the Venus Calendar while M is the close quarter century adjustment which the Egyptians may have used. Neither interval has any value in connection with eclipse syzygies.

Although the tropical year only gains a day in four years over the vague year, it furnishes a different category of approximations as regards lunar data and especially as regards lunar data arranged with an eye towards the prognostication of eclipses. The table that follows gives outstanding approximations.

TROPICAL YEARS AND ECLIPSE INTERVALS

	Tropical Years	Eclipse Seasons	Lunations
M	9 = 3287.18 days	19 = 3292.89 days	112 = 3307.43 days
N	10 = 3652.42 "	21 = 3639.51 "	123 = 3632.26 "
O	19 = 2939.60 "	40 = 6932.40 "	235 = 6939.69 "

Far and away the most important of these is O which corresponds to the famous Metonic Cycle of the Greeks. It is used by the Mayas in several of their most striking calculations as the whole number 6940 reached by simply subtracting 1 tzolkin from 1 katun, thus:

1 katun	1- 0- 0- 0	=	7200 days
1 tzolkin	13- 0	=	260 "
1 Metonic Cycle	19- 5- 0	=	6940 "

We now examine the correspondences between lunar data and the Maya calendar round of 18980 days (73 x 260=52 x 365). Since this is an odd number of tzolkins, it is apparent at once that it will show a wide discrepancy as regards eclipse seasons. The double calendar round, which happens also to be the permutation cycle of the Venus calendar, restores an approximate balance. Indeed, it develops that 37960 days are only 5.29 days greater than 219 eclipse seasons. This recession of the eclipse season, in the double calendar round, proves nearly equal to the 5.20 days recession of the actual places of Venus in the formal pattern of the Venus calendar. Also 1285 lunations are some 13.19 days, or nearly half a lunation, less than the number; a condition which might permit eclipses of different orbs to repeat.

U	1	calendar round (2–12–13– 0)	18980	days	
	110	eclipse seasons	19064.01	"	+84.01
	643	lunations	18988.17	"	+ 8.17
V	2	calendar rounds (5– 5– 8– 0)	37960	days	
	219	eclipse seasons	37954.71	"	— 5.29
	1285	lunations	37946.81	"	—13.19
W	18	calendar rounds (2– 7– 9– 0– 0)	341640	days	
	1971	eclipse seasons	341592.40	"	—47.60
	11569	lunations	341639.38	"	— .62
X	29	calendar rounds (3–16– 8–17– 0)	550420	days	
	3176	eclipse seasons	550429.91	"	+ 9.91
	18639	lunations	550419.36	"	— .64

After the conditions at the end of the second calendar round noted above no approximation of lunations is found until the eighteenth round and no approximation of both lunations and eclipse seasons until the twenty-ninth round. At this position the discrepancy of 84 days above the number at the end of the first round has been reduced to less than 10 days while the discrepancy on the lunation is less than one day. In other words, the return of an eclipse is now for the first time possible on an exact multiple of the calendar round.

The Grand Cycle of the Mayas is precisely the 29 calendar rounds which now recovers an eclipse syzygy. In this period of 550420 days the vague year gains a complete cycle of the seasons on the tropical year. It seems, from evidence that will be presented in due course, that the Mayas were well aware of this coincidence with its double bearing on astronomical fact and that they took note of eclipses which recurred after exactly 1508 calendar years and 1507 tropical years.

The Lunar Table of the Dresden Codex. The history of researches on the Lunar Table of the Dresden Codex begins with Ernst Förstemann who showed clearly enough that the numerical intervals treat lunations in groups in such fashion that a cycle or re-entering series is formed with the Maya tzolkin in 11960 days. He thought that the main purpose of the Mayas was to combine 405 revolutions of the Moon with 104 revolutions of Mercury and that the thirds into which the table of 11960 days was divided were meant for revolutions of Jupiter in groups of ten. As a matter of fact, the error on Mercury, with 115 days for the synodic period instead of the actual 115.877, amounts to 90 days and in the case of Jupiter 30 revolutions demand some 15 days more than the cycle. Förstemann had no inkling that the peculiar arrangement of the lunar intervals was concerned with eclipse possibilities. Moreover, he made several emendations in the text on the plea of uniformity which were dismissed by Bowditch in a later study of the same text.

Meinhausen was the first to publish a demonstration that the Lunar Table of the Dresden Codex was intended to strike eclipse days. He

wrote as follows in 1913: "Another indication that the numbers in the codex have arisen from the observation of eclipses lies in the fact that the exact grouping of the numbers which is brought about by the insetting of pictures in the numerical series is also possible in lunar eclipses which are visible in a particular locality."

In 1921 Carl E. Guthe published a thesis dealing with the Lunar Table. His conclusion was: "The numerical series of these pages of the Dresden record, then, an eclipse calendar which is referred to a lunar calendar."

This conclusion is entirely in keeping with the experiments of Willson, who in 1912 before the publication of Meinhausen's study, prepared a list of all solar eclipses visible in the Maya area between 31 B.C. and 1508 A.D. This he plotted on a strip of ruled paper and then he set against this strip a scale marked with the intervals between pictures in the Lunar Table of the Dresden Codex. Willson found a maximum coincidence of only seven out of the ten places in visible solar eclipses. To him belongs the distinction of being the first student who seriously attempted to find a historical place for the functioning of the Lunar Table, all others before him having merely treated the data in this manuscript as absolute evidence which revealed by sheer accuracy of mean intervals the astronomical nature of the subject matter.

In his paper published posthumously in 1924 Willson writes in connection with the Lunar Table of the Dresden Codex: "The result of this study was to confirm the opinion that no correlation of the Maya and Julian calendars could be found from the lunar series alone."

The Lunar Table displayed on pages 51-58 of the Dresden Codex covers 405 lunations in a repeating calendarial pattern of 11960 days. The lunations are grouped by fives and sixes in such fashion that the intervals between the groups are the ones which separate eclipse syzygies. The calendarial cycle is necessarily rigid, consisting of 46 x 260=11960 days, a number which is slightly in excess of the value of 405 lunations, and still more in excess of 69 eclipse seasons. From the way the table is written it is fair inference that the Mayas were aware of the recessional factors. The table departs from three days namely 10 Cimi, 11 Muluc and 12 Lamat which are successive days in the tzolkin, but the day 12 Lamat is the one appearing in certain Long Count statements found in the preamble of the table and this day is pretty clearly intended to be the principal point of departure for the calendarial pattern. The days actually designated in connection with the groups of lunations are likewise in triple order counting up to one less than the full calendar. There is also an accumulating count of bar and dot numbers which agree with intervals between the designated days for the first third of the table and then fall one place behind. The total of this series comes to 11958. Now it is true that if the start is made from 12 Lamat, the re-entering cycle of the calendar will again reach 12 Lamat while the count by days will reach 11

Muluc and by numbers 10 Cimi. Actually, all three days are recorded as bases and the designations throughout are three ply. The Venus table also has three points of departure which pretty clearly correspond to three historical places: perhaps the same idea exists here. At least it is clear that the different totals provide an opportunity to keep track of the necessary recessions. The real values of 46 tzolkins, 405 lunations and 69 eclipse seasons are as follows:

46 tzolkins	46 x 260	=	11960	days
405 lunations	405 x 29.5305	=	11959.8885	"
69 eclipse seasons	69 x 173.3092	=	11958.3248	"

The Mayas deal only with whole days but reach fractional values in the long run. Groups of six lunations are generally set down as 177 days but occasionally as 178 days, the true mean value being 177.18 days.

I now transcribe the contents of the Lunar Table of the Dresden Codex in Table VI. Column 1 gives the number of the division. Each of these concerns an eclipse syzygy which is defined in Column 2 by the ascending values of eclipse seasons and in Column 3 by the number and value of proximate lunations. Next the differences between multiples of the eclipse season and the accumulative values of the proximate lunations are set down. When this difference is small, a good eclipse interval emerges and when it is large the probabilities are against an eclipse: at least the intervals with large differences cannot be used over and over again as can those with small differences.

The best eclipse intervals are those found at Numbers 8, 15, 23, 31, 38, 46, 53, 61 and 69. It will be observed that Numbers 23, 46 and 69 are multiples of the same unit, namely the Maya Saroid which joins 23 eclipse seasons with 135 lunations and 3986 or 3987 days. Number 38 is the Saros proper and Number 61 is the most accurate of all eclipse intervals but less interesting to the Mayas than the Saroid interval which is organically related to their tzolkin.

TABLE VI

Analysis of the Lunar Table of Dresden Codex

Eclipse Season		Lunation		Difference	Interval from 12 Lamat	
Number	Days	Number	Days		Day	Day number
1	173.31	6	177.18	+ 3.87	7 Chicchan	177
2	346.62	12	354.37	+ 7.75	2 Ik	354
3	519.93	17	502.02	—17.91	7 Oc	502
4	693.24	23	679.20	—14.04	2 Manik	679
5	866.55	29	856.39	—10.16	10 Kan	856
6	1039.86	35	1033.57	— 6.29	5 Imix	1033
7	1213.17	41	1210.75	— 2.42	1 Cauac	1211
* 8	1386.48	47	1387.94	+ 1.49	9 Cib	1388
9	1559.79	53	1565.12	+ 5.31	4 Ben	1565
10	1733.10	59	1742.30	+ 9.20	12 Oc	1742
11	1906.41	65	1919.49	+13.08	7 Manik	1919
12	2079.72	70	2096.67	+16.95	2 Kan	2096
13	2253.02	76	2244.32	— 8.71	7 Eb	2244
14	2426.34	82	2421.51	— 4.83	3 Oc	2422
* 15	2599.65	88	2598.69	— .96	11 Manik	2599

TABLE VI—Continued

Analysis of the Lunar Table of Dresden Codex

Eclipse Season		Lunation		Difference	Interval from 12 Lamat	
Number	Days	Number	Days		Day	Day number
16	2772.96	94	2775.87	+ 2.91	6 Kan	2776
17	2946.27	100	2953.06	+ 6.79	1 Imix	2953
18	3119.58	106	3130.24	+10.66	9 Eznab	3130
19	3292.89	112	3277.90	+14.99	1 Cimi	3278
20	3466.20	117	3455.08	—11.12	9 Akbal	3455
21	3639.51	123	3632.26	— 7.25	4 Ahau	3632
22	3812.82	129	3809.45	— 3.37	12 Caban	3809
* 23	3986.13	135	3986.63	+ .50	8 Men	3987 (a)
2nd Saroid						
24	4159.44	141	4163.81	+ 4.37	3 Eb	4164
25	4332.75	147	4341.00	+ 8.25	11 Muluc	4341
26	4506.06	152	4488.65	+17.35	3 Caban	4489
27	4679.35	158	4665.83	—13.54	11 Ix	4666
28	4852.68	164	4843.02	— 9.66	6 Chuen	4843
29	5026.09	170	5020.20	— 5.79	2 Muluc	5021
30	5199.30	176	5197.38	— 1.92	10 Cimi	5198
* 31	5372.61	182	5374.57	+ 1.96	5 Akbal	5375
32	5545.92	188	5551.75	+ 5.83	13 Ahau	5552
33	5719.23	194	5728.93	+ 9.60	8 Caban	5729
34	5892.54	200	5906.12	+13.58	3 Ix	5906
35	6065.85	206	6083.30	+17.45	11 Chuen	6083
36	6239.16	211	6230.95	— 8.21	3 Cauac	6231
37	6412.47	217	6408.14	— 4.33	12 Caban	6409
* 38	6585.78	223	6585.32	— .46	7 Ix	6585
39	6759.19	229	6762.51	+ 3.32	2 Chuen	6763
40	6932.40	235	6939.69	+ 7.29	10 Lamat	6940
41	7105.71	241	7116.87	+11.16	5 Chicchan	7117
42	7279.02	246	7264.53	—14.49	10 Ben	7265
43	7452.33	252	7441.71	—10.62	5 Oc	7442
44	7625.64	258	7618.89	— 6.75	13 Manik	7619
45	7798.95	264	7796.08	— 2.83	8 Kan	7796
46	7972.26	270	7973.26	+ 1.00	3 Imix	7973
3rd Saroid						
47	8145.57	276	8150.44	+ 4.87	11 Eznab	8150
48	8318.88	282	8327.63	+ 8.75	6 Men	8327
49	8492.19	287	8475.28	—16.91	11 Akbal	8475
50	8665.50	293	8652.46	—13.04	6 Ahau	8652
51	8838.81	299	8829.65	— 9.16	1 Caban	8829
52	9012.12	305	9006.83	— 5.29	10 Men	9007
* 53	9185.43	311	9184.01	— 1.42	5 Eb	9184
54	9358.69	317	9361.20	+ 2.46	13 Muluc	9361
55	9532.05	323	9538.38	+ 6.33	8 Cimi	9538
56	9705.36	329	9715.56	+10.20	3 Akbal	9715
57	9878.67	335	9892.75	+14.08	11 Ahau	9892
58	10051.98	340	10040.40	—11.58	3 Lamat	10040
59	10225.29	346	10217.58	— 7.71	11 Chicchan	10217
60	10398.60	352	10394.77	— 3.83	7 Akbal	10395
* 61	10571.91	358	10571.95	+ .04	2 Ahau	10572
62	10745.22	364	10749.13	+ 3.91	10 Caban	10749
63	10918.53	370	10926.32	+ 7.79	5 Ix	10926
64	11091.84	376	11103.50	+11.66	13 Chuen	11103
65	11265.15	382	11251.15	—14.00	5 Cauac	11251
66	11438.46	387	11428.34	—10.12	13 Cib	11428
67	11611.77	393	11605.52	— 6.25	8 Ben	11605
68	11785.08	399	11782.71	— 2.34	3 Oc	11782
* 69	11958.39	405	11959.89	+ 1.50	12 Lamat	11960

(a.) Beginning with Group 23 the cumulative number recorded is 1 less than the number required to reach the recorded day. In the Group 69 the number is 11958, the number called for by the day is 11959, while the cycle demands 11960.

* The most effective eclipse intervals.

Numbers and Dates Connected with the Lunar Table. The introductory material on the upper half of pages 51 and 52 of the Dresden Codex consists of six interlocking red and black numbers counted from the Mundane Era, one pair being on the left and two pairs on the right. Between them are eleven shorter numbers usually described as a multiplication table of 11960 although there are either errors or intentional variations from exact multiples. Several emendations in the carelessly written numerals of the six long numbers are necessary but these have long since been agreed upon by Förstemann, Bowditch and other students.

The first column reads down as follows: 4 Ahau, 8 Cumhu, 12 Lamat, 8 days, knotted Imix. Then come the numbers 8-16- 4- 8- 0 and 10-19- 6- 1- 8, with 12 Lamat repeated at the bottom of the column. In one case 4 Ahau 8 Zip is reached and when 8 days are added we find 12 Lamat 11 Zip. In the other case 12 Lamat 6 Cumhu is reached and when the 8 days are substracted we obtain 4 Ahau 18 Kayab. The transformation into Gregorian dates under Correlation A (equation 489384) with the approximate age of the moon appended is as follows:

A	13– 0– 0– 0– 0,	4 Ahau	8 Cumhu,	Oct. 14, 3373 B.C.		
	8–16– 4– 8– 0	add				
B	8–16– 4– 8– 0,	4 Ahau	3 Zip,	Aug. 23, 101 A.D.		11.7
	8	add				
C	8–16– 4– 8– 8,	12 Lamat	11 Zip,	Aug. 31, 101 A.D.		19.7

* * *

A	13– 0– 0– 0– 0,	4 Ahau	8 Cumhu,	Oct. 14, 3373 B.C.		
	10–19– 6– 1– 8	add				
D	10–19– 6– 1– 8,	12 Lamat	6 Cumhu,	Nov. 28, 950 A.D.		10.4
	8	subtract				
E	10–19– 6– 1– 0,	4 Ahau	18 Kayab,	Nov. 20, 950 A.D.		2.4

The multiplication table, so-called, lying to the right of Long Count statements just transcribed, consists of eleven numbers, to wit:

1st term	1–18– 5– 0	=	13780	=	1 x 11960	+	1820
2nd term	3– 6– 8– 0	=	23920	=	2 x 11960		
3rd term	4–19–12– 0	=	35880	=	3 x 11960		
4th term	6–12–16– 0	=	47840	=	4 x 11960		
5th term	8– 6– 2– 0	=	59800	=	5 x 11960		
6th term	9–19–12– 0	=	71880	=	6 x 11960	+	120
7th term	1– 6–11–10– 0	=	191360	=	16 x 11960		
8th term	1– 8– 4–14– 0	=	203320	=	17 x 11960		
9th term	1– 9–18– 0– 0	=	215280	=	18 x 11960		
10th term	2–11–10–11– 0	=	371020	=	31 x 11960	+	260
11th term	3– 4–15–12– 0	=	466440	=	39 x 11960		

Then come four other Long Count statements and a suppressed fifth date represented only by the tzolkin designation 5 Ben.

F	9–16– 4–10– 8, 15	12 Lamat	1 Muan,	Jan. 11, 496 A.D.	10.
G	9–16– 4–11– 3, 1	1 Akbal	16 Muan,	Jan. 26, 496 A.D.	25.
H	9–16– 4–11–18,	3 Eznab	11 Pax,	Feb. 11, 496 A.D.	10.5
		* * *			
F	9–16– 4–10– 8, 3– 0–15– 0	12 Lamat	1 Muan,	Jan. 11, 496 A.D.	10.
I	9–19– 5– 7– 8, 15	7 Lamat subtract	1 Muan,	Dec. 28, 555 A.D.	27.8
J	9–19– 5– 6–13,	5 Ben	6 Kankin,	Dec. 13, 555 A.D.	12.8

It will be observed at once that none of these are full or new moon dates under Correlation A. Several of them have, however, precisely the same real age of the moon, 25 and 10 days, respectively, as the full or new moon phases in the Supplementary Series. I have repeatedly expressed the belief that an uncorrected lunar calendar was used by the Mayas and that the data of the Supplementary Series must be interpreted in connection with a method of recording lunations with an accumulating error.

Eclipse Series on 12 Lamat. Ludendorff's demonstration that the Maya tzolkin found its most probable origin in eclipse phenomena observed by the Mayas during the eighth and seventh centuries before Christ validates the reasonableness of research on this temporal frontier of Maya science. The tzolkin itself must have been devised largely on eclipses of the moon, as we have seen. But eclipses of the sun when they did occur were surely held in greater awe than those of the moon. One of the most striking eclipses of the sun in this early formative period was an annular eclipse with a line of centrality passing close to Copan which Oppolzer describes as eclipse number 1067 in his monograph[1]. It took place in astronomical terms on -752, XI, 18, Julian day 1446712.

This date, transcribed into the Maya Long Count and the Gregorian calendar, under Correlation A becomes:

6-12-19- 4- 8, 12 Lamat 1 Muan, Nov. 10, 752 B.C.

Here is a momentous eclipse syzygy lying just 24 calendar rounds before the much-mooted 12 Lamat 1 Muan of the Dresden Codex. Was this the real eclipse which later astronomers used as the point of departure in far-flung computations?

12 Lamat is three days before 2 Chuen which Ludendorff makes one of the foci of eclipses in the original tzolkin but this small displacement does not militate in any way against his argument and, indeed, is part and parcel of it. If 12 Lamat is found as a day for eclipses of the sun, it will also be found for eclipses of the moon. Without classifying the entire lunar record we can locate empirically lunar eclipses on 12 Lamat by

[1] This eclipse was followed in six lunations by another having its path of totality a little to the south of Copan (-751 V 15).

counting forward and backward from known places where solar eclipses occupy this day such double tzolkin multiples as are 14 or 15 days over exact lunations. Perhaps the most serviceable one is thirteen tuns, or 4680 days; this number is 14.17 days over 158 lunations and 15.36 days under 157 lunations. It is also possible to use 7280 days which is 15.47 days over 246 lunations and 14.06 days under 247 lunations. If 9880 is used the mean adjustment is 16.78 days over 334 lunations and 12.75 days under 335 lunations: in this case the eclipse of the moon would probably be a day or two before or after 12 Lamat depending on whether the interval had been added to the place of a 12 Lamat solar eclipse, or subtracted from it.

Actually this 12 Lamat 1 Muan eclipse of the Sun referred to above ushered in a considerable series of both the sun and the moon separated by the interval of the Maya lunar cycle and the other intervals discussed above. In seven turns of this cycle four visible eclipses of the sun, three of large magnitude, were produced.

TABLE VII

THE FIRST 12 LAMAT SERIES OF VISIBLE ECLIPSES OF THE SUN

Maya Long Count	Julian Day	Gregorian Date
** 6–12–19– 4– 8, 12 Lamat 1 Muan	1446712	Nov. 10, 752 B.C.
1–13– 4– 0	11960	
6–14–12– 8– 8, 12 Lamat 16 Yax	1458672	Aug. 7, 719
1–13– 4– 0	11960	
** 6–16– 5–12– 8, 12 Lamat 11 Xul	1470632	May 9, 686
1–13– 4– 0	11960	
6–17–18–16– 8, 12 Lamat 6 Uo	1482592	Feb. 5, 653
1–13– 4– 0	11960	
6–19–12– 2– 8, 12 Lamat 6 Pax	1494552	Nov. 4, 621
1–13– 4– 0	11960	
** 7– 1– 5– 6– 8, 12 Lamat 1 Ceh	1506512	Aug. 3, 588
1–13– 4– 0	11960	
* 7– 2–18–10– 8, 12 Lamat 16 Yaxkin	1518472	May 2, 555

* Visible eclipse of small magnitude
** Visible eclipse of large magnitude
Eclipses unstarred were not visible in Maya territory

The last two visible eclipses of the series took place after the formalization of the Maya day count on August 6, 613 B.C.

Now we have already observed that the calendar round is an ineffective interval for eclipses except that two calendar rounds may convert an eclipse of the sun into one of the moon or vice versa, and that 29 calendar rounds may produce another similar eclipse in the terms of both the Maya and European calendars. Indeed, if we add 29 calendar rounds to the last eclipse of the sun on 12 Lamat in Table VII we do reach the

opening number of another series of 12 Lamat eclipses. The addition is first given:

* 7– 2–18–10– 8, 12 Lamat 16 Yaxkin, May 2, 555 B.C.
3–16– 8–17– 0
*10–19– 7– 9– 8, 12 Lamat 16 Yaxkin, May 1, 952 A.D.

Both of these dates are eclipses of the sun visible at Copan: the placing of a leap year intercalation just before the last date makes a difference of 1 day in the Gregorian calendar but actually the interval is very close to 1507 tropical years.

TABLE VIII

THE SECOND 12 LAMAT SERIES OF VISIBLE ECLIPSES OF THE SUN

Maya Long Count		Julian Day	Gregorian Date
*10–19– 7– 9– 8,	12 Lamat 16 Yaxkin	2068892	May 1, 952 A.D.
1–13– 4– 0		11960	
11– 1– 0–13– 8,	12 Lamat 11 Zip	2080852	Jan. 28, 985
1–13– 4– 0		11960	
11– 2–13–17– 8,	12 Lamat 11 Kayab	2092812	Oct. 28, 1017
1–13– 4– 0		11960	
*11– 4– 7– 3– 8,	12 Lamat 6 Mac	2104772	Aug. 30, 1050
1–13– 4– 0		11960	
**11– 6– 0– 7– 8,	12 Lamat 1 Chen	2116732	Apr. 25, 1083
1–13– 4– 0		11960	
**11– 7–13–11– 8,	12 Lamat 16 Zotz	2182692	Jan. 23, 1116
1–13– 4– 0		11960	
*11– 9– 6–15– 8,	12 Lamat 16 Cumhu	2140652	Oct. 21, 1148
1–13– 4– 0		11960	
**11–11– 0– 1– 8,	12 Lamat 11 Kankin	2152612	July 20, 1181
1–13– 4– 0		11960	
11–12–13– 5– 8,	12 Lamat 6 Yax	2164572	Apr. 18, 1214
1–13– 4– 0		11960	
**11–14– 6– 9– 8,	12 Lamat 1 Xul	2176532	Jan. 15, 1247

* Visible eclipses of small magnitude
** Visible eclipses of large magnitude
Eclipses unstarred were not visible in Maya territory

Here we have seven visible eclipses, five of them in sequence, in ten turns of the lunar cycle. The fifth eclipse was total at Copan and the last one nearly so. The period, extending from 950 A.D. to 1250 A.D., must fall pretty close to the time when the Dresden Codex was intended to be used as an astronomical *vade mecum*. I have elsewhere pointed out that the three Venus calendars of this codex under the regents 1 Ahau 18 Kayab, 1 Ahau 13 Mac and 1 Ahau 13 Xul functioned in conjunction with heliacal risings of Venus for several centuries, beginning about 934 A.D. and that during the same epoch eclipses were falling on the days recorded in the Lunar Table.[1] On artistic grounds the date of the Dres-

[1] 1928, pp. 14-15 and addendum of September 10, 1928 (p. 4). The lunar data was developed in a paper read before the Congress of Americanists at New York in 1928.

den Codex must be placed not far from 1200 A.D. A specific detail on which comparisons can be made is the warrior with the bird on his forehead, Tutul Xiu style, on page 60 of the document (see Figure 7).

Before leaving the field in which the second set of 12 Lamat eclipses are found, I wish to put on record the distribution of all the eclipses of the sun visible in Maya territory from 950 to 1250 A.D. Table IX is a portion of Willson's MS Table of Visible Eclipses which in the original extends from 12 B.C. to 1508 A.D. Table X is a classification of the same eclipses under the tzolkin days in three organic groupings. It will be seen at once that Group 1 centered on 12 Lamat has 55 eclipses; Group

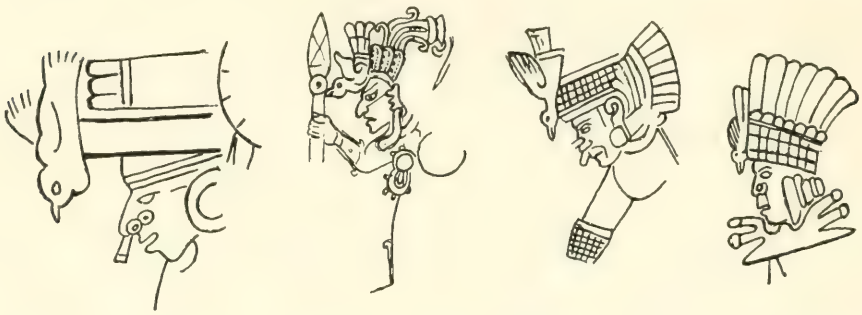


Fig. 7. The Bird on the Forehead—a dynastic emblem of the Toltecs in Yucatan. First example, Thompson's Lintel, Chichen Itza, dated October 16, 1209; third example, page 60, Dresden Codex; others, Temple of the Jaguars, Chichen Itza.

II, on 3 Imix has only 21 and Group III on 7 Ix has 47. The day 12 Lamat leads all others with seven eclipses. 3 Eb in Group I and 2 Muluc in Group III follow with 5 eclipses. 7 Akbal and 7 Ix have four eclipses to their credit and several other days have three. A classification of lunar eclipses for the same chronological limits would doubtless follow along much the same lines of distribution as do these of the sun.[1]

TABLE IX

VISIBLE ECLIPSES OF THE SUN COINCIDING WITH DAYS OF LUNAR TABLE 950 A.D. TO 1250 A.D.

Number	Oppolzer No.	Mag.*	Julian Cal.	Julian Day	Time	Maya Day
†1	5132	0.1	952 IV 26	2068892	Sunset	12 Lamat
2	5135	0.3	953 X 10	2069424	4.00 P.M.	11 Ahau
3	5140	0.5	956 II 14	2070281	10.00 A.M.	10 Caban
4	5143	0.3	957 VII 29	2070812	10.00 A.M.	8 Lamat
5	5149	0.1	959 XII 2	2071668	Sunset	6 Kan
6	5151	0.2	960 XI 21	2072023	8.00 A.M.	10 Cauac
7	5159	0.9	964 III 16	2073234	11.00 A.M.	12 Oc
8	5167	0.8	968 I 2	2074621	4.00 P.M.	8 Caban

[1] I find a series of thirteen lunar eclipses on 12 Lamat separated by the interval of 11960 days, beginning J.D. 2064212, 939 VII 4. Of these eleven were visible in Maya territory.

TABLE IX—Continued

Number	Oppolzer No.	Mag.	Julian Cal.	Julian Day	Time	Maya Day
9	5168	0.0	968 VI 28	2074799	9.00 A.M.	4 Men
10	5175	0.6	971 IV 27	2075832	11.00 A.M.	10 Lamat
11	5184	0.0	975 VIII 10	2077398	Sunset	3 Ix
12	5192	0.1	979 V 28	2078785	8.00 A.M.	12 Imix
13	5198	0.7	981 IX 30	2079641	Sunset	10 Caban
14	5207	0.4	985 VII 20	2081030	7.30 A.M.	8 Cimi
15	5210	0.1	987 I 2	2081561	Noon	6 Caban
16	5213	0.2	988 V 18	2082063	Sunrise	1 Cauac
17	5231	0.6	995 XII 24	2084839	10.00 A.M.	8 Men
18	5232	0.9	996 VI 18	2085016	1.00 P.M.	3 Eb
19	5234	0.1	997 VI 7	2085370	5.00 P.M.	7 Manik
20	5249	0.8	1003 VII 31	2087615	4.00 P.M.	2 Chuen
21	5250	0.1	1004 I 24	2087792	Sunrise	10 Lamat
22	5258	0.2	1007 XI 12	2089180	3.00 P.M.	7 Cib
23	5260	0.2	1008 X 31	2089534	1.00 P.M.	10 Oc
24	5265	1.0	1010 III 18	2090037	8.30 P.M.	7 Ix
25	5268	0.8	1011 VIII 31	2090568	9.00 A.M.	3 Akbal
26	5283	0.7	1018 IV 18	2092990	10.00 A.M.	8 Cimi
27	5292	0.6	1022 II 3	2094377	5.00 P.M.	4 Ben
28	5299	1.0	1025 V 29	2095588	9.00 A.M.	6 Kan
29	5307	0.1	1028 III 28	2096622	Sunset	13 Eznab
30	5309	0.1	1029 III 17	2096976	Sunset	3 Eb
31	5318	0.1	1033 VI 29	2098541	Sunrise	8 Caban
32	5324	1.0	1035 XI 2	2099397	Sunset	6 Ben
33	5325	0.3	1036 IV 28	2099575	Sunset	2 Chuen
34	5335	0.4	1040 VIII 10	2101140	11.00 A.M.	7 Cib
35	5341	0.7	1043 VI 9	2102173	Sunset	1 Oc
36	5354	0.2	1048 IX 10	2104093	5.00 P.M.	9 Muluc
37	5358	1.0	1050 I 25	2104595	3.00 P.M.	4 Chuen
† 38	5359	0.0	1050 VII 21	2104772	Sunrise	12 Lamat
39	5361	0.3	1051 VII 10	2105126	12.30 P.M.	2 Ik
40	5376	0.6	1057 IX 1	2107371	2.00 P.M.	11 Manik
41	5377	0.0	1058 II 25	2107548	Sunrise	6 Kan
42	5386	0.3	1061 XII 14	2108936	4.00 P.M.	3 Eb
43	5388	0.6	1062 XII 3	2109290	1.30 P.M.	6 Cimi
44	5393	0.8	1064 IV 19	2109793	Sunrise	2 Muluc
45	5396	0.7	1065 X 2	2110324	9.00 A.M.	13 Ahau
46	5411	0.2	1072 V 20	2112746	10.00 A.M.	4 Ik
47	5421	0.4	1076 III 7	2114133	Sunset	13 Muluc
48	5423	0.7	1077 II 25	2114488	Sunrise	4 Kan
49	5429	0.6	1079 VII 1	2115344	Sunrise	2 Ahau
† 50	5439	1.0	1083 IV 19	2116732	4.00 P.M.	12 Lamat
51	5446	0.4	1086 II 16	2117766	Sunrise	6 Ik
52	5454	0.6	1089 XII 4	2119153	Sunset	2 Muluc
53	5455	0.8	1090 V 31	2119331	5.00 P.M.	11 Manik
54	5466	1.0	1094 IX 12	2120896	7.30 A.M.	3 Eb
55	5474	0.7	1097 VII 11	2121929	4.00 P.M.	9 Chicchan
56	5476	0.3	1098 VII 1	2122284	Sunrise	13 Ahau
57	5487	0.6	1102 X 13	2123849	5.00 P.M.	5 Chicchan
58	5492	0.2	1104 II 27	2124351	4.30 P.M.	13 Manik
59	5495	0.9	1105 VIII 11	2124882	9.00 A.M.	11 Eznab
60	5502	0.7	1108 XII 4	2126093	Sunrise	13 Muluc
61	5503	0.8	1109 V 31	2126271	Sunrise	9 Manik
62	5510	0.3	1111 X 4	2127127	1.00 P.M.	7 Akbal
† 63	5521	0.5	1116 I 16	2128692	3.00 P.M.	12 Lamat

TABLE IX—Continued

Number	Oppolzer No.	Mag.	Julian Cal.	Julian Day	Time	Maya Day
64	5531	0.2	1117 I 4	2129046	4.00 P.M.	2 Ik
65	5530	0.0	1119 XI 4	2130080	Noon	9 Cib
66	5538	0.3	1122 IX 2	2131113	Sunset	2 Muluc
67	5539	0.5	1123 II 27	2131291	4.00 P.M.	11 Manik
68	5546	0.3	1125 XII 26	2132324	Sunrise	4 Ahau
69	5556	0.7	1130 IV 9	2133889	5.00 P.M.	9 Chicchan
70	5558	0.7	1131 III 30	2134244	7.00 A.M.	13 Ahau
71	5565	0.0	1133 VIII 2	2135100	Sunrise	11 Cib
72	5574	0.6	1137 V 21	2136488	10.00 A.M.	8 Kan
73	5576	0.0	1138 V 10	2136842	2.00 P.M.	11 Eznab
74	5582	0.9	1140 III 20	2137522	6.30 A.M.	2 Eznab
75	5587	0.0	1142 VIII 22	2138407	2.00 P.M.	3 Akbal
76	5591	0.0	1144 I 6	2138909	Sunset	11 Chicchan
77	5592	0.4	1144 VII 2	2139087	2.00 P.M.	7 Akbal
† 78	5602	0.4	1148 X 14	2140652	Sunrise	12 Lamat
79	5604	0.0	1149 X 3	2141006	Sunrise	2 Ik
80	5610	0.2	1151 VIII 13	2141685	1.00 P.M.	5 Imix
81	5612	0.5	1152 VIII 2	2142040	Sunrise	9 Cib
82	5619	0.9	1155 VI 1	2143073	Sunset	2 Muluc
83	5622	0.2	1156 XI 14	2143605	Sunset	1 Imix
84	5620	0.8	1159 IX 13	2144639	7.00 A.M.	7 Ix
85	5638	0.0	1163 I 6	2145849	9.00 A.M.	9 Chicchan
86	5645	0.7	1165 XI 5	2146883	2.00 P.M.	3 Cauac
87	5656	0.5	1170 II 17	2148448	2.00 P.M.	8 Kan
88	5657	0.0	1170 VIII 13	2148625	4.30 P.M.	3 Imix
89	5658	0.0	1171 II 6	2148802	1.00 P.M.	11 Eznab
90	5665	0.0	1173 XII 6	2149836	3.30 P.M.	5 Eb
91	5674	0.8	1177 III 31	2151047	4.00 P.M.	7 Akbal
92	5682	0.7	1180 I 28	2152080	8.00 A.M.	13 Cib
† 93	5685	0.7	1181 VII 13	2152612	8.30 A.M.	12 Lamat
94	5692	0.7	1184 V 11	2153645	3.30 P.M.	5 Imix
95	5694	0.7	1185 V 1	2154000	Sunrise	9 Cib
96	5710	0.3	1191 VI 23	2156244	Sunrise	4 Ahau
97	5712	0.4	1192 VI 11	2156598	9.30 A.M.	7 Ix
98	5713	0.4	1192 XII 6	2156776	7.00 A.M.	3 Eb
99	5717	0.2	1194 IV 22	2157278	8.00 A.M.	11 Ix
100	5722	0.8	1196 IV 23	2158163	2.30 P.M.	12 Cauac
101	5730	0.6	1199 VII 24	2159197	5.00 P.M.	6 Ben
102	5738	0.2	1202 XI 16	2160408	Sunrise	8 Kan
103	5739	0.0	1203 V 12	2160585	3.00 P.M.	3 Imix
104	5746	0.1	1205 IX 14	2161441	1.00 P.M.	1 Caban
105	5748	0.3	1206 IX 4	2161796	Sunrise	5 Eb
106	5757	0.0	1209 XII 28	2163007	6.15 A.M.	7 Akbal
107	5765	0.4	1213 X 15	2164394	7.30 A.M.	3 Oc
108	5774	0.0	1217 II 7	2165605	10.30 A.M.	5 Imix
109	5782	0.7	1219 XII 8	2166639	3.30 P.M.	13 Cib
110	5784	0.0	1220 XI 26	2166993	4.00 P.M.	2 Muluc
111	5793	0.0	1224 III 21	2168204	10.00 P.M.	4 Ahau
112	5794	0.0	1224 IX 14	2168381	3.30 P.M.	12 Caban
113	5795	0.0	1225 III 10	2168558	Noon	7 Ix
114	5802	0.2	1227 VII 15	2169415	Sunset	6 Chuen
115	5803	0.7	1228 I 8	2169592	Sunset	1 Lamat

TABLE IX—Continued

Visible Eclipses of the Sun Coinciding with Days of Lunar Table 950 A.D. to 1250 A.D.

Number	Oppolzer No.	Mag.	Julian Cal.	Julian Day	Time	Maya Day
116	5810	0.7	1231 V 3	2170803	1.30 P.M.	3 Cauac
117	5813	0.0	1232 X 15	2171334	Sunrise	1 Oc
118	5818	0.4	1234 III 1	2171836	8.00 A.M.	9 Eb
119	5829	0.4	1238 VI 13	2173401	1.00 P.M.	1 Caban
120	5831	0.0	1239 VI 3	2173756	Sunrise	4 Chuen
121	5839	0.2	1242 IV 1	2174789	Sunset	11 Chicchan
122	5850	0.6	1246 VII 14	2176354	Sunrise	3 Oc
†123	5851	0.9	1247 I 8	2176532	10.00 A.M.	12 Lamat

* Vicinity of Copan, Honduras.

† Eclipse on 12 Lamat

TABLE X

Visible Eclipses of the Sun, 950–1250 A.D., and Days of the Maya Tzolkin

(The numbers refer to sequence of the eclipses in Table IX)

	Group I	Group II	Group III
9 Eb	118	13 Chicchan	4 Eznab
10 Ben		1 Cimi	5 Cauac
11 Ix	99	2 Manik	6 Ahau
12 Men		3 Lamat	7 Imix
13 Cib	92, 109	4 Muluc	8 Ik
1 Caban	104, 119	5 Oc	9 Akbal
2 Eznab	74	6 Chuen 114	10 Kan
3 Cauac	86, 116	7 Eb	11 Chicchan 76, 121
4 Ahau	68, 96, 111	8 Ben	12 Cimi
5 Imix	80, 94, 108	9 Ix	13 Manik 58
6 Ik	51	10 Men	1 Lamat 115
7 Akbal	62, 77, 91, 106	11 Cib 71	2 Muluc {44, 52, 66, 82, 110
8 Kan	72, 87, 102	12 Caban 112	3 Oc 107, 122
9 Chicchan	55, 69, 85	13 Ezenab 29	4 Chuen 37, 120
10 Cimi		1 Cauac 16	5 Eb 90, 105
11 Manik	40, 53, 67	2 Ahau 49	6 Ben 32, 101
12 Lamat	{1, 38, 50, 63, 78, 93, 123	3 Imix 88, 103	7 Ix 24, 84, 97, 113
13 Muluc	47, 60	4 Ik 46	8 Men 17
1 Oc	35, 117	5 Akbal	9 Cib 81, 65, 95
2 Chuen	20, 33	6 Kan 5, 28, 41	10 Caban 3, 13
3 Eb	{18, 30, 42, 54, 98	7 Chicchan	11 Eznab 59, 73, 89
4 Ben	27	8 Cimi 14, 26	12 Cauac 100
5 Ix		9 Manik 61	13 Ahau 45, 56, 70
6 Men		10 Lamat 10, 21	1 Imix 83
7 Cib	22, 34	11 Muluc	2 Ik 39, 64, 79
8 Caban	8, 31	12 Oc 7	3 Akbal 25, 75
9 Eznab		13 Chuen	4 Kan 48
10 Cauac	6	1 Eb	5 Chicchan 57
11 Ahau	2	2 Ben	6 Cimi 43
12 Imix	12	3 Ix 11	7 Manik 19
13 Ik		4 Men 9	8 Lamat 4
1 Akbal		5 Cib	9 Muluc 36
2 Kan		6 Caban 15	10 Oc 23
Total	55	Total 21	Total 47

The question now comes up: what supporting evidence can be found for the assumption that the Maya lunar calculations rest on the two 12 Lamat series of eclipses separated by a barren interval of 1507 years? We have already taken cognizance of the multiplication table, so called, in the preamble to the Lunar Table. This contains a considerable number of true multiples of 11960, namely the 2nd, 3rd, 4th, 5th, 16th, 17th, 18th and 39th multiples and it contains the 1st multiple + 1820 days, the 6th + 120 days and the 31st + 260 days. Now 29 calendar rounds, or 550420 days, are 46 × 11960 + 260. By using the 31st multiple with its extra tzolkin in combination with others of the normal type we can exactly construct the required number of the Grand Cycle. In other words, the Mayas have provided the means to bridge the barren interval.

In the course of 1507 years the recession of eclipse seasons in groups of three from tzolkins in groups of two, suffices in combination with an extra tzolkin, to find new coincidences of eclipses on the designated days of the Lunar Table. The Grand Cycle of 29 calendar rounds accomplishes this revitalization of the table with little to spare since 550420 days are nearly ten days short of 3176 eclipse seasons. The discrepancy is reduced at the rate of 1.675 days for each new lunar cycle that is added to 550420 days, the neatest conformity being found after five or six lunar cycles have been counted beyond the Grand Cycle.

The dates recorded in the Dresden Codex furnish support of a more striking nature. The latest chronological statement in the MS occurs in the very preamble to the Lunar Table which we have been considering and combines two dates 8 days apart, namely:

10–19– 6– 1– 0, 4 Ahau 18 Kayab, Nov. 20, 950 A.D.
8
10–19– 6– 1– 8, 12 Lamat 6 Cumhu, Nov. 28, 950

The first of these is a Venus date in the 1 Ahau 18 Kayab calendar and exactly reaches an heliacal rising of the planet four days after inferior conjunction. The second is a 12 Lamat date with the same age of the moon (10 days) as the famous 9-16- 1-10- 8, 12 Lamat 1 Muan, (date F of the Lunar Table and the lunar base of the Supplementary Series on Stela M at Copan). Also it had coincided with an eclipse of the moon 13 tuns before the date when 12 Lamat 1 Muan reached an eclipse of the sun or at 6-12- 6- 4- 8, 12 Lamat 6 Cumhu (J.D. 1442032). The double tzolkin is, as we have seen, an important tool in eclipse calculations since it equals 3 eclipse seasons. If we now add a double tzolkin to the declared 12 Lamat 6 Cumhu we get the first of the visible 12 Lamat eclipses in the second series: that is:

10–19– 6– 1– 0, 4 Ahau 18 Kayab, Nov. 20, 950, Heliacal Rising of Venus
8
10–19– 6– 1– 8, 12 Lamat 6 Cumhu, Nov. 28, 950, Moon 10 days old
1– 8– 0
10–19– 7– 9– 8, 12 Lamat 16 Yaxkin, May 1, 952, Visible eclipse of Sun.

The knotted Imix symbol may imply addition of two tzolkins (1- 8- 0).

What is the significance of all this as regards the specific problem of testing the relative merits of Correlations A and B? Since the placement of tzolkin days is agreed upon, it is obviously possible to find substitute Long Count statements of the dates in the Julian period which reach the two eclipse series on 12 Lamat; for instance:

J.D. 1446712	Correlation A	6–12–19– 4– 8, 12 Lamat 1 Muan
	Correlation B	5–19–15–11– 8, 12 Lamat 1 Muan
J.D. 1518472	Correlation A	7– 2–18–10– 8, 12 Lamat 16 Yaxkin
	Correlation B	6– 9–14–17– 8, 12 Lamat 16 Yaxkin
J.D. 2068982	Correlation A	10–19– 7– 9– 8, 12 Lamat 16 Yaxkin
	Correlation B	10– 6– 3–16– 8, 12 Lamat 16 Yaxkin

But it is seen at a glance that the terminal dates of the first series of 12 Lamat eclipses of the sun which under Correlation A precede and follow Baktun 7 must under Correlation B precede or follow Baktun 6. Now the evidence which indicates that Baktun 7 was the historical zero of the formal day count cannot be interpreted to apply to Baktun 6. On the other hand, the dates in the Lunar Table with positions fixed in the Maya Long Count are effective in still another fashion in that they are coordinated with new Julian days under Correlation B and brought nearer the present, thus:

10–19– 6– 1– 0, 4 Ahau 18 Kayab	Correlation A, J.D. 2068364, (Nov. 20, 950 A.D.)	
	Correlation B, J.D. 2163264, (Sept. 18, 1210 A.D.)	

The Maya date that under Correlation A coincides with an heliacal rising of Venus in close touch with an eclipse of the sun on 12 Lamat under B is separated by nearly 260 years from the eclipse in question and no longer has any discernible significance in connection with either Venus or the moon.

The Supplementary Series

In his paper sponsored by the Carnegie Institution of Washington, Teeple presents in somewhat fuller detail than previously his studies on the so-called Supplementary Series of glyphs which follow Initial Series in about 130 inscriptions of the ancient Mayas. His original analysis led him, as has been stated above, to the important conclusion that the coefficients of Glyph C record a number of complete lunations never exceeding six while Glyph D or Glyphs D and E in combination (with E appearing as 20 days) give the moon's age during the course of a single lunation. His demonstration is acceptable in its broader outlines as affording an answer to the puzzle of the Supplementary Series, at least in so far as the numerical contents of Glyphs C, D and E are concerned. But several major assumptions made by Teeple in his interpretation of these glyphic statements are not necessarily true. One is that the days of the moon

were reckoned by the ancient Mayas from the new moon phase. Another is that the statements in the Supplementary Series were readings of a current moon. Still a third is that the various bases of the moon count coincided with eclipses of the sun during part of the time when the Supplementary Series was in vogue. However attractive these assumptions may be on *a priori* grounds, exception could be taken to all of them if occasion should arise. Unable to establish a correlation on his own lunar date, Teeple has recently turned to the haven of Correlation B because this arrangement comes within a day or two of satisfying the first two of these three final assumptions.

The date of departure of the Lunar Calendar, 9-16- 4-10- 8, 12 Lamat 1 Muan, does not strike an eclipse syzygy under Correlation B. This discrepancy seems the more notable because this date actually is reached as a lunar base in the Supplementary Series on Stela M at Copan, where the Initial Series registers 9-16- 5- 0- 0, 8 Ahau 8 Zotz, and the Supplementary Series calls for a zero position five lunations and five days earlier.

There is, then, a pretty clear organic relationship between this Supplementary Series placement during the First Empire and the Lunar Calendar of the Dresden Codex, giving this date an unavoidable significance in connection with eclipses.

It appears from the evidence that the Supplementary Series was first used with different bases for C but about the same day of the moon for DE; then came a period lasting for some 60 years during which C was uniformly counted with six lunations to a group from identical bases. Obviously such an arrangement would not bring back eclipse syzygies, for occasional groups of five lunations are a prime necessity. Indeed for most of the time that the Supplementary Series was in use we may be quite certain that it did not function in connection with eclipses, although doubtless having some ceremonial relation to these phenomena. Thus the distance between the lunar bases of Stela 18 at Uaxactun and Stela 12 at Copan—the two earliest examples of Supplementary Series if we omit projections into the distant past—reduces to about 39459 days which is some 44 days over 228 eclipse seasons and therefore well out of the limits of repeating eclipses. Or if we take two monuments at the latter city, say Stela 7 and Stela 9, we find the lunar bases are 14437 days apart, whereas 83 eclipse seasons call for only 14385 days, a discrepancy far beyond the range of repeating eclipses. The period of uniformity in the handling of the Supplementary Series is followed by a period of re-separation, to use Teeple's phrase, with Stela M at Copan being the monument on which the break is first in evidence. Under Teeple's hypothesis an eclipse syzygy should be reached which is certainly not the case when dates are converted by Correlation B. The date 9-17- 0- 0- 0, 13 Ahau 18 Cumhu does strike a visible eclipse on J.D. 2002684 under this corre-

lation. But for this position the Supplementary Series of several texts record either 2C or 3C, giving cold comfort.

The failure of 9-16- 4-10- 8, 12 Lamat 1 Muan, to strike an eclipse under Correlation B compels Teeple to suspect the authority of this date in connection with the Dresden Codex. He now writes:

> Can we date the Table? I formerly supposed with others that its zero date was 9-16- 4-10- 8, 12 Lamat 1 Muan, but I am now doubtful. We mentioned that Copan abandoned the uniform moon numbering in 9-16- 5- 0- 0 and changed to some grouping which might be the eclipse syzygy grouping mentioned above. . . . The date 9-16- 4-10- 8, 12 Lamat 1 Muan, in the context shows its importance in this connection and is probably sufficient to assure us that Copan actually did start the eclipse arrangement on that date with Stela M, but it does not necessarily give us the date of the present table since 10 or 11 such tables may have been used through and discarded between Stela M and this one in the Dresden Codex.

Now if we move forward from 9-16- 4-10- 8, 12 Lamat 1 Muan at jumps of 11960 days, we ultimately strike the second 12 Lamat eclipses of the sun which I have already put on record. But the Supplementary Series of the classical age cannot be vitalized from coincidences in the twelfth century. Teeple nowhere proves or even suggests a way in which the cycle of 11960 days can be corrected.

Let us now examine the conditions under Correlation A and a scheme of interpretation entirely different from the one used by Teeple. Long before solution of the Supplementary series was announced it was apparent that the definite dates recorded with the Lunar Calendar in the Dresden Codex did not find new moons or full moons under Correlation A, nor did they come near visible eclipses. Instead the most prominent of these Dresden Codex dates reached ages of 10 and 25 days, a condition which it seemed possible to explain on the basis of a recession of approximately four days for the principal lunar phases between the inauguration of the Maya time counts in the seventh century before Christ and the times of the First Empire. If the lunar cycle of 11960 days was supposed by the Mayas to be a correct statement of 405 lunations, the true places of the moon would form a precession and in the sixth century A.D. the moon would be about 4 days in front of the calendar. When Teeple published his first analysis of the Supplementary Series this hypothesis became for me a practical certainty. Three dates at Palenque showed the same rate of recession (.11 of a day in 11960 days) over a much longer period. These three dates are compared below with the first historic monument having a Supplementary Series.

	Initial Series Date	ED+C	Lunar Base
I Temple of the Cross	12–19–13– 4– 0	64.06	12–19–13– 0–15.94
II Temple of the Sun	1–18– 5– 3– 6	144.12	1–18– 4– 4– 1.88
III Temple of Foliated Cross	1–18– 5– 4– 0	158.65	1–18– 4– 4– 1.88
IV Stela 18, Uaxactun	8–16– 0– 0– 0	54.53	8–15–19–15– 5.47

The interval between the base of I and the common base of II and III is 277265.94 days which overruns 9389 lunations by 3.24 days. The difference between the common base of II and III and the hypothetical moon referred to in IV is 992023.59 days which overruns 33593 lunations to the extent of 8.15 days. Finally the checking calculation based on the interval between I and IV, which amounts to 1269289.53 days, overruns 42994 lunations by 11.39 days or exactly the sum of excess in the other instances. In every case the actual places of the moon vary from the formal places by recession from a true coincidence in the seventh century before Christ by the minute error of the formula, 405 lunations=11960 days.

Although this recession is at so slow a rate that it cannot be caught with certainty during the 521 years covered by the truly historic record of the Supplementary Series, yet the evidence compels Teeple to make the following admission:

> There was apparently a one-day change at the time of the introduction of the standard calendar and this would be just about the amount necessary to change from a disappearance of the old moon to the first appearance of the new moon.

Proceeding now on the double supposition that Correlation A is correct and that the use of the 11960-day cycle from 7- 0- 0- 0- 0, 10 Ahau 18 Zac, causes a recession of four days in the ages of the real moon from the calendar moon, it follows that the lunations of the Supplementary Series are calculated from full moons rather than new moons. That is:

Full Moon + 4 days = first day of the Supplementary Series.

New Moon + 4 days = fifteenth day of the Supplementary Series.

For if a mean of four days is added to the E and D column in Table 2 of Teeple's paper for the Carnegie Institution, the resulting ages of the moon will be found to coincide with true ages beginning from the full phase.[1]

Now if this argument is correct both the true and the calendarial statements of the moon's places have significance under Correlation A while under Correlation B significance is restricted to real places of new and full moons. But a graph constructed on all the certain statements of E and D from Teeple's tabulation is presented in Figure 8. It shows that more dates on true half lunation points are found under Correlation A than under Correlation B, the proportions being 28 to 19. Moreover, the 19 under B also have significance under A making the comparison stand 55 for Correlation A against the original 19 for Correlation B. The formal statement follows:

	Full Moon		New Moon		Totals
	Real	Calendarial	Real	Calendarial	
Correlation A	20	13	8	6	55
Correlation B	6	0	13	0	19

[1] The variation of the Supplementary Series statements is frequently one and sometimes two days on either side of this mean.

The peaks on the graph at 9 and 25 days are explained by the reverse process as cyclic new and full moons in terms of the true phases. I omit these from the tabulation.

Fig. 8. Graph showing distribution of days of the Moon in Supplementary Series Statements. At each end is Day 29, with Day 0 in second place on left. The peaks are Day 5 and Day 25, found in 9 and 8 inscriptions respectively.

We have already seen that 12 Lamat coincides with eclipses of the sun as well as those of the moon at the time the Maya time count was set in motion and again after the lapse of one Grand Cycle of 1507 years. We have also seen that the situation in the Supplementary Series can be explained on the basis of the Mayas using the number 11960 as the true value of 405 lunations to reach calendarial ages of the moon, counted from a full moon base. An explanation by an astronomer of the way in which eclipse data was handled in the intermediate period between true 12 Lamat epochs has just reached the light. It should be sufficient to settle once and for all the controversy over the interpretation of the Supplementary Series and the dates in connection with the Lunar Calendar of the Dresden Codex.

Cyclic Eclipses. Ludendorff, in a second article entitled *On the Reduction of Maya Datings to our Time Reckonings,* calls attention to the fact that my correlation (Correlation A) has failed to convince all Maya students and that a further discussion is positively necessary to examine an astronomical objection. This astronomical objection is the one based on the interpretation of the Supplementary Series construed in conformity with the Lunar Calendar of the Dresden Codex. I translate Ludendorff's words beginning with a reference to the leading date in the preamble of the Lunar Calendar:

> On page 52a on the extreme right, that is immediately before the beginning of the tables on 53a, stands the Maya date:
>
> 9-16- 4-10- 8, 12 Lamat 1 Muan
>
> and from the declaration of the tzolkin day descriptions on the subsequent pages it is imperative that this date be placed at the beginning of the eclipse calendar. Therefore, it is to be expected that on the named day an eclipse of the sun or moon took place. Reducing this date, indicated in short as A, to decimal notation we find:
>
> A = M.D. 1412848

and with the help of the Spinden correlation:

A = J.D. 1902232 = Jan. 11, 496 Julian Calendar.

But according to Th. von Oppolzer's Canon of Eclipses no eclipse took place on this date. The nearest eclipse of the moon fell on November 18, 495 = J.D. 1902178; the nearest eclipse of the sun on November 3, 495 = J.D. 1902163: however, the latter was partial and not visible at all in the Maya area. From this the natural conclusion is that the Spinden correlation denies completely a clear set of facts and therefore cannot be correct. Nevertheless we shall see that the argument against the Spinden correlation may be accounted for by a simple adjustment and transformed in the end into a splendid confirmation of the correlation.

We will adopt the working hypothesis that the Spinden correlation as well as the views developed in my Publication 1 are correct so far as concerns the way in which the tzolkin originated, and the manner and time of its stabilization. . . . At the epoch of the introduction of the tzolkin, that is about 7- 0- 0- 0- 0, 613 B.C., eclipses could only occur on those new and full moon dates which were in proximity to the days 1 Imix and 2 Chuen in every other tzolkin and to the day 6 Kan in the intermediate tzolkin. This rule would have continued to function if the tzolkin period of 260 days had not been too long by $0^d.0362$. On account of this error the eclipse phenomena move gradually forward in the tzolkin. In one baktun the error amounts to 20 days, i.e., after one baktun the three tzolkin days mentioned above must be replaced by three others which precede them by twenty days. There is certainly a possibility that the Mayas in predicting eclipses first reckoned the tzolkin period as absolutely correct with 260 days—I describe such reckoning as cyclic—and that they afterwards corrected the calculation in respect to the error in the periods (even today the same thing is done in astronomical procedure). The date A is followed in three days by:

B. 9-16- 4-10-11, 2 Chuen = J.D. 1902235 = January 14, 496, Julian Calendar.

In order to see whether, according to cyclic reckoning, eclipses could have fallen on the new and full moon times near this 2 Chuen day we first have to determine whether B is an even number of tzolkins away from those 2 Chuen days which correspond to the time of the assumed 7- 0- 0- 0- 0. According to Table 3, beta, of my Publication 1, J.D.1496635 is such a 2 Chuen day. This day lies 405600 days = 1560 tzolkins before date B. Since 1560 is an even number, B fulfills the conditions required.

According to the Tables of H. Gr. Guiness, the new moon lying nearest to date B falls on January 1, 496 and the nearest full moon on January 16, 496. These are the *real* days of new and full moon. But we shall have to suppose that the Mayas here also used a cyclic reckoning. How this cyclic reckoning was procured we do not know.[1] But when . . . we consider the researches of J. E. Teeple concerning the so-called Supplementary Series of hieroglyphs, often found with statements of dates, in the light of the Spinden correlation it appears that the cyclicly-reckoned full moon lay, at date A, about four days short of the true full moon. . . . In order not to break into our train of thought we postpone detailed discussion of this question and assume that at date A the cyclic full moon lay in fact four days before the true. It fell accordingly on January 12, 496 only one day after date A. This variation of one day will be considered permissible because the time statements of the Maya are in whole days so that errors of one day can occur easily in the rounding out.

We may thus summarize the result of these considerations: if the Mayas first reckoned the eclipses cyclicly, i.e., if they looked upon the tzolkin period as absolutely exact and also used the cyclic date for the time of the full moon, this reckoning gave them the day 9-16- 4-10- 8, 12 Lamat 1 Muan, as the day of a cyclic (not a real) eclipse of the moon. Thus the beginning date of the Dresden eclipse series has found a new meaning. . . .

Ludendorff, after checking the calculation, gives a description of the special features of this lunar eclipse of J.D. 1902178: it was visible as a total obscuration in the Maya territory near the zenith and must have

[1] It was procured, as I show above, through the use of the formula 405 lunations = 11960 days. Ludendorff also reaches this conclusion towards the end of his paper.

been an impressive phenomenon. He next applies the number arrangement of the Dresden Codex, i.e., the accumulative count in the upper zone of the table, recorded on pp. 53a to 58a and 51b to 58b, to this date as the recondite beginning of an ephemeris (avoiding the day names which follow from the unreal cyclic eclipse) and finds that all the lunar eclipses during the tested period of 11960 days visible anywhere in the world are reached within a day, excepting a single eclipse which was so minute as not to be observable; this is a lunation after the position of the table. The proportion of visible eclipses exactly placed is somewhat greater than the proportion of invisible eclipses (visible eclipses, 25 exactly placed, 7 one day off; invisible eclipses, 8 exactly placed, 12 one day off). This seems to indicate that real observations were made even though a formal pattern had been carried forward.

The German astronomer continues his proofs, considering a second date or pair of dates recorded in the preamble of the Dresden Codex corresponding to August 23 and 31, 101 A.D. in the Gregorian Calendar. These are:

8–16– 4– 8– 0, 4 Ahau 3 Zip, J.D. 1758 184
8–16– 4– 8– 8, 12 Lamat 11 Zip, J.D. 1758 192

In this case the recession of the tzolkin eclipse positions from the epoch of the Historical Era amounts to 36 days, contrasting with 56 days for the previous date, and the recession of the full moon itself to about three days instead of four.[1]

The date 8-16- 4- 8- 0, 12 Lamat 11 Zip, becomes under Ludendorff's demonstration another eclipse date of the cyclic type, the real eclipse falling 37 days earlier on J.D. 1758157. The full moon is here only three days before the calendar. As regards the one day error which develops here, as in the other case, we may find a possible explanation in the likelihood that the Maya day began at sunset—a lunar eclipse before midnight would fall in the same day as one coming after midnight. The eclipse of J.D. 1758157 was total and visible in the Maya area, being entirely in agreement with the one previously examined, so that the numbers of the Dresden Codex table can again be applied.

As regards the date 10-19- 6- 1- 8, 12 Lamat 6 Cumhu, which corresponds to J.D. 2068372, Ludendorff points out that it lies 4 days after a total eclipse of the moon which was, however, not visible in Maya territory. I have explained above that this date is joined by a declared 8 days with 10-19- 6- 1- 8, 4 Ahau 18 Kayab, Nov. 20, 950, Greg. Cal., which is precisely an heliacal rising of Venus in accordance with the Venus tables of the Dresden Codex, and that if one double tzolkin, perhaps implied in a knotted Imix symbol, is added to 12 Lamat 6 Cumhu we strike

[1] The interval between the two recorded bases is 144040 days or just two uinals above a baktun and it seems possible that the Mayas may have allowed one day for the recession of the lunation and 20 days for the recession of the eclipse season over this round number.

the first member of an important series of eclipses of the sun on 12 Lamat. This argument is not in any way contradictory to Ludendorff's demonstration but is an amplification of it.

Eclipses Recorded on Monuments of the First Empire. Also as a further amplification of Ludendorff's argument I now present evidence that a considerable number of eclipses are accurately recorded on their true rather than their cyclic dates on monuments of the First Empire. This should be enough to dispose of the idea that the use of a cyclic method precludes accurate knowledge of the real places.

Stela C, Copan

In 1928, I wrote the following concerning the inscription on Stela C at Copan. "This Stela refers to interlocking counts of the moon and of Venus, as the moon and Venus titles in the two introducing glyphs plainly indicate." In the analysis made at that time[1] I showed that the round number with which the calculation began, namely, 9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452 A.D., coincided with the first appearance of Venus as morning star about four days after inferior conjunction and that the very long distance number leads back to a position which combines one of the celebrated days of the Venus Calendar in the Maya year (18 Kayab) with one of its positions in the natural year (April 12) while the number itself is approximately 19 × 243 years (19 times the 243 year cycle of Venus and the natural year, or 243 times the Metonic cycle of the moon and the natural year). That is:

9–14– 0– 0– 0, 6 Ahau 13 Muan, Feb. 4, 452 A.D.
11–14– 5– 1– 0
10–19–14–17– 0, 6 Ahau 18 Kayab, Apr. 12, 4165 B.C.

To be sure the multiple is not exact as regards days but the fact that use of the Metonic cycle is clearly enough implied in three other dates on he monument gives color to the suggestion. These three dates are:

9–14–19– 5– 0, 4 Ahau 18 Muan, Feb. 4, 471
9–14– 9– 5– 0, 5 Ahau 8 Cumhu, Mar. 28, 461
9–14–18– 0– 0, 4 Ahau 18 Uo, May 20, 470

Subtracting one Metonic cycle from the first date (which also appears on Stelae A and H and Altar U) we get 9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452 already treated. Subtracting the same interval from the second date gives 9-13-10- 0- 0, 7 Ahau 3 Cumhu, Mar. 28, 442, while twice the interval taken from the last date gives 9-13- 0- 0- 0, 8 Ahau 8 Uo, May 19, 432.

What I did not know at the time of making the above analysis is that the second date, and its lahuntun base were days on which solar eclipses fell. The eclipse of 9-13-10- 0- 0, 7 Ahau 3 Cumhu (J.D. 1882584) was

[1] Spinden, 1928, *a*, pp. 51-54.

probably not visible to the Mayas, but must have been expected, while the second eclipse of 9-14- 9- 5- 0, 5 Ahau 8 Cumhu (J.D. 1889524) was visible at sunset with a magnitude of 0.2. This date had outstanding interest for the Mayas because the month position, 8 Cumhu, is precisely that of their Mundane Era.

Altar U, Copan

I need not discuss Altar U of Copan with its calculations concerning the astronomical base line further than to say that the date which coincides with the place in the natural year of the Initial Series on Stela 10, the western marker of this base line, reaches exactly a visible eclipse of the moon. This date is 9-15- 9- 0- 2, 9 Ik 10 Mol, Sept. 6, 480 A.D., J.D. 1896626.

Many other dates at Copan doubtless carry eclipse significances but at this time I cannot take the space for the preliminary explanations required to bring them out.

Stela 1, Los Higos

The Initial Series on this monument reaches the summer solstice and also a solar eclipse syzygy, although the eclipse was not visible to the Mayas: 9-17-10- 7- 0, 9 Ahau 3 Tzec, June 22, 521 A.D. The double significance is worthy of note.

Stela 11 and Associated Monuments—Yaxchilan

The gorgeous Stela 11 at Yaxchilan has as its earliest date 9-15- 9-17- 6, 12 Cib 19 Yaxkin, Aug. 26, 481 which coincides with a lunar eclipse on J.D. 1896980. The double Initial Series reads 9-16- 1- 0- 0, 11 Ahau 8 Tzec, July 3, 492 A.D. This date is pretty clearly associated with the summer solstice: the same sign serves as title in the introducing glyph of Stela 1 at Los Higos which strikes the summer solstice and 11 Ahau 3 Tzec will itself reach this point of the natural year one calendar round after the Initial Series placement on Stela 11 at Yaxchilan. Other dates of Stela 11 are involved in the Venus calendar as I have elsewhere shown and the calculations interlock with those of several lintels at the same city. Reverting to 9-16- 1- 0- 0, 11 Ahau 8 Tzec, July 3, 492, we find ourselves just 8 days before a solar eclipse syzygy. On Lintel 1 this date is restated while in the accompanying text is a Lamat sign. Now Lamat is 8 days after Ahau and we may therefore have 9-16- 1- 0- 8, 6 Lamat 16 Tzec, July 11, 492, which would exactly reach the solar eclipse syzygy referred to on J.D. 1900952. The eclipse itself was not visible to the Mayas. On Lintel 21 there is a record of 9-16- 1- 0- 9, 7 Muluc 17 Tzec, July 12, 492, the day after the eclipse date. In connection with these declarations we find hieroglyphs that are excellent ideographs of eclipses (see Figure 9).

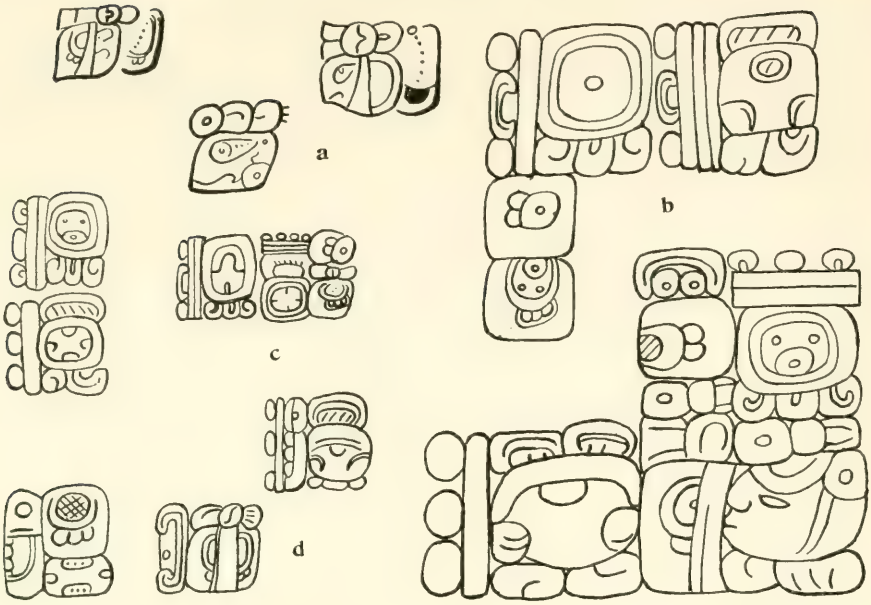


Fig. 9. Tieing up the Moon: *a*, the moon tied up in the Dresden Codex; *b*, a solar eclipse syzygy Lintel 21 Yaxchilan; *c*, a visible eclipse of the moon, Stela 11, Yaxchilan; *d*, three records of 11 Ahau 8 Tzec, near an eclipse, Yaxchilan.

Stela 12, Piedras Negras

Perhaps the most interesting eclipse configuration at Piedras Negras is the one which appears on the very beautiful Stela 12. The three dates on this monument, according to Morley's readings are:

9–17–16–14–19,	1 Cauac 12 Zac, Oct. 28, 527:	J.D. 1913843
8– 3– 1		2941
9–18– 5– 0– 0,	4 Ahau 13 Ceh, Nov. 16, 535	1916784
1–13	subtract	33
9–18– 4–16– 7,	10 Manik 0 Zac, Oct. 14, 535	1916751

The last date is a solar eclipse syzygy on the place in the natural year of the epoch of the Mundane Era, 13- 0- 0- 0- 0, 4 Ahau 8 Cumhu, Oct. 14, 3373 B.C. This configuration may be compared with the one reaching 8 Cumhu on Stela C at Copan. The eclipse on this day was a partial one, not visible in the Maya area. Indeed Oppolzer shows two partial eclipses of the sun a lunation apart, one on 513-IX-13 and the next on 513-X-12, our J.D. 1916751. The mean tzolkin day at this epoch must be halfway between, or on 8 Eb or 9 Ben, one of which also should furnish a lunar eclipse.

Altar 2 and Stela 11, Piedras Negras

The number 1- 8- 6-18, which amounts of 10218 days, one of the

eclipse intervals in the Dresden Codex, is recorded on two monuments at Piedras Negras in the following association:

9–13– 9–14–15, 7 Men 18 Kankin, Jan. 22, 422 A.D.
1– 8– 6–18
9–14–18– 3–13, 7 Ben 16 Kankin, Jan. 13, 470
1–14– 7
9–15– 0– 0– 0, 4 Ahau 13 Yax, Oct. 22, 471

None of these dates are near eclipse syzygies although 7 Men and 7 Ben are eligible days.

Interlocking Eclipse Dates at Naranjo

The following five dates serve to interlock the calculations on six monuments at Naranjo:

			Stela	3	24	29		22	30
A	9–12–10– 5–12,	4 Eb 10 Yax,	Oct. 31, 422	*I.S.	*I.S.	*I.S.	....	.....	
B	9–12–15–13– 7,	9 Manik 0 Kayab,	Mar. 8, 428	....	*	*	....	*I.S.	....
C	9–13–10– 0– 0,	7 Ahau 3 Cumhu,	Mar. 28, 442	....	*	....	....	*	....
D	9–14– 1– 3–19,	3 Cauac 2 Pop,	Apr. 18, 453	*	....	....	*I.S.	....	*
E	9–14– 3– 0– 0,	7 Ahau 18 Kankin,	Jan. 19, 455	....	....	*	....	....	*(3)

Date A, recorded by these Initial Series, equals J.D. 1875496 which is the day before J.D. 1875497 of solar eclipse No. 3872 of Oppolzer's Canon. This was a partial eclipse not visible in Maya territory. Date B has no apparent significance in connection with eclipses, preceding by over three months a very prominent obscuration of the sun. Date C is a lahuntun which coincides with a solar eclipse syzygy although the phenomenon was not visible. Date D follows some distance after an almost total eclipse of the sun on J.D. 1886571 but cannot be connected with it. Date E, recorded three times on Stela 30, is a tun ending one day before an eclipse of the moon on J.D. 1887265, not visible, I believe.

Venus and Eclipse Dates at Tikal

At Tikal Stela 16 is associated with the splendid round Altar 5. The stela has a priestly figure with a Venus sign on his headdress and the altar has two priests with sacrificial knives standing before a heap of human bones and a skull. The stela bears a single date, namely, the katun ending 9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452, which justifies the Venus symbol on the headdress. The coincidence of this round number with an heliacal rising of Venus is elsewhere explained. The four dates on Altar 5 are of the calendar round variety and when placed in their nearest positions after the date on the stela run as follows:

A 9–15–12– 7– 9, 1 Muluc 2 Muan, Jan. 15, 484, J.D. 1897853
11–11–18 4198
B 9–16– 4– 1– 7, 13 Manik 0 Xul, July 15, 495, J.D. 1902051
8– 9–19 3079
C 9–16–12–11– 6, 11 Cimi 19 Mac, Dec. 20, 503, J.D. 1905130
3 3
D 9–16–12–11– 9, 1 Muluc 2 Kankin, Dec. 23, 503, J.D. 1905123

Date A has a double meaning. First it records a day of heliacal setting of Venus, eight days before heliacal rising and four short Venus cycles less one day, from the katun ending declared on Stela 16. Secondly, this heliacal setting practically coincides with a solar eclipse position and thus reaches a time when Venus and the moon are in combined conjunction with the sun. The Mayas had witnessed on Julian day 1897674 an eclipse of the sun and had doubtless already discovered that six lunations later another might be expected. Actually a solar eclipse did take place on Julian day 1897852, the day before date A, but it was not visible in Central America.

No special astronomical significance is revealed for date B but date C is again the day after an eclipse, this time of the moon and in coincidence with the winter solstice. Date D is placed three days later, on December 23, 503, in the backward projection of the Gregorian calendar. Out of five dates on these two monuments we have two that refer to Venus and two to the eclipse table and each of the eclipse days has a double significance.

Also at Tikal another eclipse day is recorded with a one day error on Lintel 1 of Temple II. The statement is as follows:

A	9–15–10– 0– 0,	3 Ahau	3 Mol, Aug. 30, 481, J.D. 1896984
	2–11–12			
B	9–15–12–11–12,	6 Eb	0 Pop, Apr. 8, 484, J.D. 1897936
	1			
C	9–15–12–11–13,	7 Ben	1 Pop, Apr. 9, 484, J.D. 1897937
	3– 2– 7			
D	9–15–15–14– 0,	3 Ahau	13 Uo, May 11, 487, J.D. 1899064

Here the first date, August 30, is the reciprocal date for April 12 in the third and present arrangement of the astronomical line of sight at Copan, the second date is the Maya New Year's day which has receded one day from the position of the second arrangement (April 9-September 2) but which is restored in date C. The fourth and last date may well refer to the solar eclipse position at Julian day 1899063, even though the eclipse itself was not visible in Maya territory. Examination of the date discloses that an important solar eclipse with a magnitude of .6 took place about noon on Julian day 1897674 about a tzolkin before B and C.

Temple of the Sun, Palenque

At Palenque on the Temple of the Sun I find the following passage:

8–19– 6– 8– 8,	11 Lamat	6 Xul, Oct. 10, 162, J.D.	1780512
13– 3– 9			4749
8–19–19–11–17,	2 Caban	10 Xul, Oct. 11, 175,	1785261
6– 3			123
9– 0– 0– 0– 0,	8 Ahau	13 Ceh, Feb. 10, 176,	1785384

The first of these dates is an eclipse of the moon and the last, Baktun

9, is a full moon day much used in calculation. An eclipse of the moon took place 30 days before on J.D. 1785354.

Altar G and Stela K, Quirigua

On Altar G a series of dates begins with a 9 Ahau 3 Yax which reduces to J.D. 1907784. Others are 2, 3, and 12 days in advance of this. An eclipse of the sun, not visible in Maya territory, took place on J.D. 1913089 two days after the third date. It does not seem likely that an eclipse significance can be attached to this passage.

Altar K records:

9–18–15– 0– 0, 3 Ahau 3 Yax, Sept. 24, 545
10–10
9–18–14– 7–10, 1 Oc 18 Kayab, Feb. 26, 545

The first date is a solar eclipse syzygy on a hotun and also practically on the autumnal equinox. The second date reaches 18 Kayab of the Venus calendar and the introducing glyph carries the Venus symbol.

Eclipses on Round Numbers

The round numbers which coincide with solar eclipse syzygies are:

9– 2–10– 0– 0, 3 Ahau 8 Cumhu, May 25, 225, J.D. 1803384
9–13–10– 0– 0, 7 Ahau 3 Cumhu, Mar. 28, 442, 1882584
9–18–15– 0– 0, 2 Ahau 3 Yax, Sept. 24, 545, 1921384

All of these are prominently treated in Maya inscriptions. It is possible that the eclipse on the first number was visible in some parts of the Maya area but in any case the dates could have been reached by calculation and could in turn have served as bases in further calculation.

We have seen that an eclipse of the moon preceded 9- 0- 0- 0- 0, 8 Ahau 13 Ceh, by one lunation. The number 9-11- 0- 0- 0, so prominently dealt with at Copan, is a full moon date coming 14 days after a visible eclipse of the sun on J.D. 1864570. Then Baktun 10 (J.D. 1929384) comes 6 days before a solar eclipse syzygy on J.D. 1929390. The date of this eclipse in the Gregorian calendar is May 23, 571 only two days short of the position occupied by the eclipse of 9- 2-10- 0- 0.

It is apparent that the Maya methods of handling current eclipses were rather varied. In a number of cases, which I have not put down, there is a difference of four days between the eclipse and the recorded date, suggesting that the cyclic moon may have been put down instead of the real moon.

Sacred Day of the Moon. It appears that a group of two or three days in the first half of January may have had some special significance in regard to the moon, forming a sacred day or period in terms of the natural year. The date 9-10-15- 0- 0, 6 Ahau 13 Mac, Jan. 11, 388 A.D. was a full moon day which in combination with 9-11- 0- 0- 0, 12 Ahau 8 Ceh, Dec. 15, 392, received considerable attention, especially at Copan. One of these dates may have been a little before full moon and

the other a little after, since a hotun is 1.37 days over 61 mean lunations.

If we add one short Venus cycle to 9-10-15- 0- 0, 6 Ahau 13 Mac, we recover 1 Ahau 13 Mac on January 9, 396 A.D. On the Tablet of the Foliated Cross at Palenque the Initial Series records 1-18- 5- 4- 0, 1 Ahau 13 Mac, Jan. 8, 2618 B.C.: this is 2 × 29 calendar rounds or two Grand Cycles from the 1 Ahau 13 Mac already examined. It is also a fact that if we add 11960 days to the 1 Ahau 18 Kayab that serves as the base of the Venus Table of the Dresden Codex we get 1 Ahau 13 Mac in the first position, thus:

9– 9– 9–16– 0, 1 Ahau 18 Kayab, Apr. 12, 363 A.D.
1–13– 4– 0
9– 4– 3– 2– 0, 1 Ahau 13 Mac, Jan. 9, 396

It seems therefore that we may be justified in thinking that January 9 was the sacred day of the moon.

Hieroglyphs of Eclipses and Lunations. In Figures 9 and 10 I give sections of text which contain hieroglyphs for eclipses. In some cases the hieroglyph for sun is combined with *akbal* which means darkness. In other cases the moon is tied up perhaps to suggest death. Or a knot may be placed above it and a bone below. Further search would

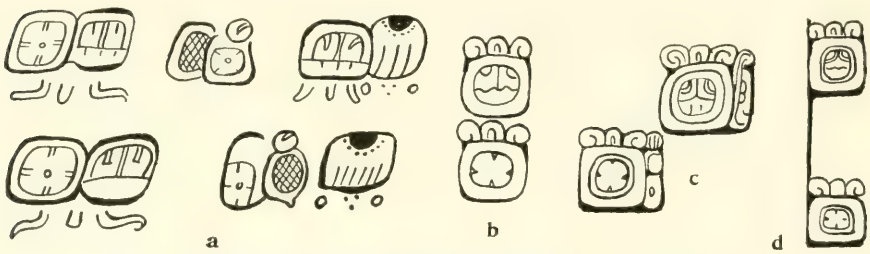


Fig. 10. Ahau-Akbal or Sun Darkness Glyphs: *a*, Dresden Codex; *b-d*, stelae at Naranjo.

perhaps reveal a fuller series of ideographs for eclipses. Also I wish to call attention to the hand-and-moon symbol for zero largely used in connection with period ending declarations and the spectacle-like symbol of similar use that so closely resembles the Venus glyph. Perhaps both of these signs have a primary significance in relation to the moon and Venus, and become ending signs merely by extension. The hand-and-moon symbol is nicely illustrated in connection with the ending statements of 9-10-15- 0- 0, 6 Ahau 13 Mac, and 9-11 -0- 0- 0, 12 Ahau 8 Ceh, both of which reach full moons.

In concluding this section on the lunar calculations of the Mayas I wish to emphasize that only in accordance with the terms of Correlation A do we find the original setting of 12 Lamat days for eclipses in the eighth and seventh centuries before Christ, the cyclicly-recorded eclipse dates of the First Empire and other current phenomena on their true

dates. While the second series of 12 Lamat eclipses can be given places under either Correlation A or Correlation B supporting numbers are not found under the latter arrangement. The demonstration of Ludendorff clinches the problem of the Supplementary Series, showing that this moon count agrees with the Maya philosophy of uncorrected calendars. Teeple, in his paper sponsored by the Carnegie Institution of Washington, uses the Supplementary Series as a bludgeon to beat down the credibility of Correlation A rather than as a positive argument in favor of Correlation B. His reasoning is defeated by the demonstration of Ludendorff.

The supposed eclipse record of Santa Elena given by Teeple in an addendum to his last article is really two days out of the way from Correlation B as he uses it with 12 Lamat eclipses. The accompanying hieroglyph was explained by Palacios as a likely symbol for the equinox and under Correlation A the date is 9-17-19-13-16, 5 Cib 14 Chen, Sept. 19, 530 A.D., which actually is near the autumnal equinox.

The Evidence from Venus

While the shift of five calendar rounds, made by passing from Correlation A to Correlation B, nearly equalize the difference between a cyclic full moon four days after real full moon and a current new moon ($14.53 + 4 = 18.53$ days), because 94900 days happen to be 18.22 days in excess of 3212 lunations, the same shift must raise havoc with a count of Venus years however construed. The formal Venus calendar runs its course in a double calendar round and odd calendar rounds are precisely on opposite sides of the cycle. The true places of Venus recede 5.2 days in the double calendar round and five calendar rounds amount to 162 Venus years plus 304.96 days. The chronological evidence resting on Venus not only carries a much larger factor of safety than does that resting on the much shorter lunation but the shift which may find a new schematic arrangement on the moon fails utterly to find a new and consistent relation to Venus.

References to Venus in Maya art are much more impressive than those which concern the moon. There is a grotesque monster frequently represented in architectural and monumental sculpture which I venture to call the Venus Monster. The reptilian body is double-headed, the front head generally carrying a Venus symbol in the eye, or sometimes on the earplug or attached to a leg, while the rear head has the sun sign on the forehead combined with elements of death, particularly a bare bone for the lower jaw. Under the terms of Correlation A the dates found in connection with sculptures of this type either reach the inferior conjunction of Venus and the sun or have some demonstrable cyclic connection with this astronomical configuration. There is ample evidence that both the Aztecs and the Mayas believed the eight day obscuration of Venus between the heliacal setting as evening star and the heliacal rising as morning star (with the inferior conjunction in a middle position) was

a period fraught with great fatalities. Indeed the ensuing calamities are pictured in the Venus Table of the Dresden Codex in conformity with those shown in the ancient manuscripts of other Central American peoples.

Venus Hieroglyphs which Coincide with Phenomena. I have already put on record in previous articles a considerable number of exact statements of heliacal risings of Venus which occur in the inscriptions in connection with the Venus hieroglyphs, and have outlined the cyclic elements of a ceremonial Venus Calendar which must be invoked to explain other dates. Briefly it appears that this ceremonial calendar was

a b

Fig. 11. Dates of Heliacal Risings of Venus: *a*, Block 6 Hieroglyphic Stairway at Naranjo; *b*, Stela 23, Naranjo.

of the uncorrected type carried forward from an inauguration in the sixth century before Christ in a fashion quite in keeping with other uncorrected calendars of the Mayas dealing with the year and the lunation.

Let me establish first of all the fact that there are current readings a plenty which under the terms of Correlation A find Venus phenomena in places where Venus hieroglyphs also exist. I begin with one very clear and unchallengeable case. On Block 6 of the Hieroglyphic Stairway at Naranjo there is a date standing next to a Venus sign over a new-fire sign (see Figure 11). This date is placed exactly in the Long Count by means of the recorded distance number 1- 1- 17 which leads to 1 Ahau 8 Kayab at the close of Katun 10. The date is 9- 9-18-16- 3, 7 Akbal 16 Muan, Feb. 26, 372 A.D., or Julian day 1856987. This is just four days after inferior conjunction of Venus on Julian day 1856983 and is in complete agreement with the construction of the Venus Calendar on pages 46 to 50 of the Dresden Codex. The validity of this Venus record was passed upon at a conference on the Maya correlation problem held at Washington in 1927 under the auspices of the Carnegie Institution.

Let us suppose that the text which agrees so neatly with Correlation A is true. Then the following coincidences and approximate coincidences of heliacal risings and round numbers in the Maya day count must also have taken place at the height of the First Empire.

TABLE XI. ROUND NUMBERS AND VENUS CONJUNCTIONS

9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452 A.D.
Maya day 1396800 = Julian day 1886184
Inferior conjunction of Venus, Julian day 1886179.0

9-17- 0- 0- 0, 13 Ahau 18 Cumhu, Mar. 27, 511 A.D.
Maya day 1418400 = Julian day 1907784
Inferior conjunction of Venus, Julian day 1907783.6

10- 0- 0- 0- 0, 7 Ahau 18 Zip, May 17, 570 A.D.
Maya day 1440000 = Julian day 1929384
Inferior conjunction of Venus, Julian day 1929386.9

10- 3- 0- 0- 0, 1 Ahau 3 Yaxkin, July 6, 629, A.D.
Maya day 1461600 = Julian day 1950984
Inferior conjunction of Venus, Julian day 1950990.3

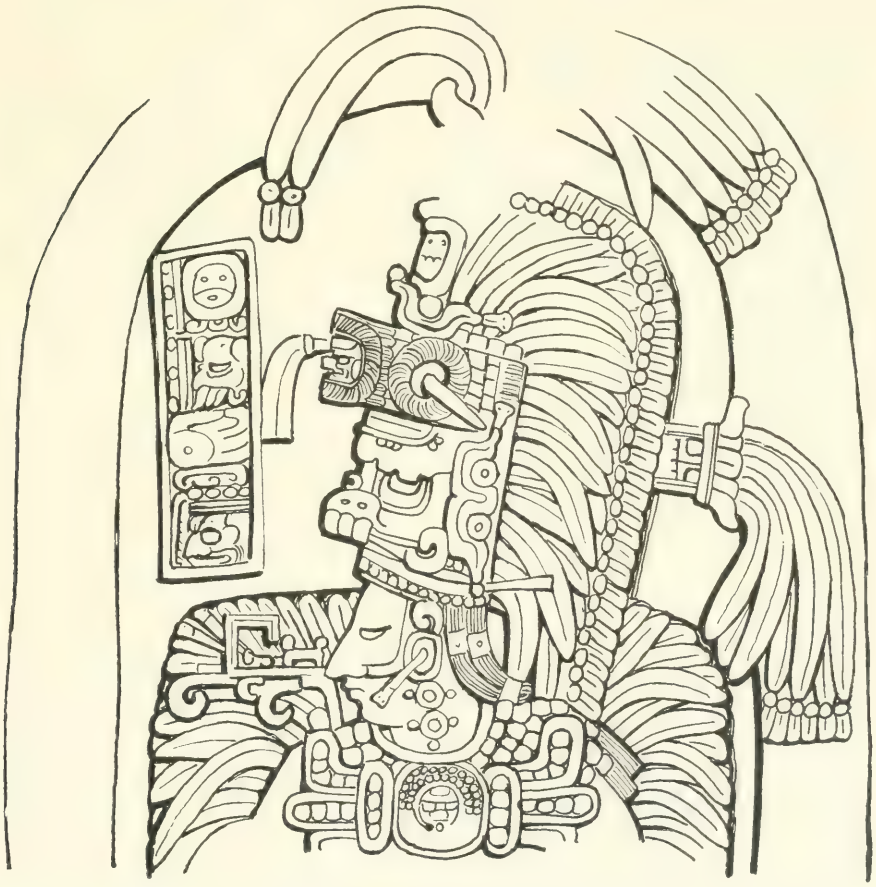


Fig. 12. Upper part of Stela 16, Tikal, showing head-dress representing Venus Monster with Venus sign at back of grotesque face. The date is 6 Ahau 13 Muan end of Katun 14.

Hieroglyphs of Venus are found in connection with all of these dates. Thus Stela 16 at Tikal registers the first round number of the series and a large Venus symbol appears on the headdress of the sculptured personage, the date itself being recorded in front of this headdress (see Figure 12). Altar 5 stands before this stela and on it are recorded two eclipse syzygies, already mentioned, one located at the heliacal setting of Venus 32 Maya years after the katun-ending. Likewise Stela C at Copan has a very clear Venus symbol in Glyph A3, south side of the monument, in connection with a distance number which reaches from 9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452 A.D. to 10-19-14-17- 0, 6 Ahau 18 Kayab, Apr. 12, 4162 B.C. One of these dates is a real coincidence whereas the other has a cyclic meaning under the Venus Calendar. Also on this stela a visible eclipse of the sun is registered, this eclipse falling on 8 Cumhu of the Mundane Era while the Metonic Cycle, repeatedly applied, proclaims that the commentary was purposeful, not accidental. Without discussing the supporting evidence of other records of this Katun 14 I pass on to the next round number of the series.

The building called *22a* at Copan was renamed the Temple of Venus by Morley because three large Venus symbols interrupt the inscription on the inner step. The same Maya scholar deciphered the date on this step as 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, but without reducing it to the Gregorian position March 27, 511 A.D. While arguing for the identification of 12-9- 0- 0- 0, 13 Ahau 8 Kankin, with the Katun 13 Ahau of the Spanish Conquest, Morley did not use my day-for-day correlation. He cannot therefore be accused of renaming this temple out of deference to an astronomical significance which the day-for-day adjustment of Correlation A discloses.

Altars G3 and Z, and the Reviewing Stand of the Western Court at Copan also register Katun 17 and furnish texts which are strikingly similar to the one on the step of the Temple of Venus. It seems not unlikely that all these monuments were votive offerings to prevent the calamities which the Mayas associated with the period of obscuration of Venus. Other monuments of this date corroborate the record at Copan.

The next coincidence of the series falls at Baktun 10, a time apparently awaited with great dread. On Altar S at Copan a Venus glyph is associated with the statement of this date. Finally we come to 10- 3- 0- 0- 0, 1 Ahau 3 Yaxkin, July 6, 629 A.D. By this time the phenomena of Venus had receded to such an extent, in comparison with katuns in groups of three, that the planet was still visible as evening star when the new period closed. But this monument has two unmistakable glyphs of Venus in combination with the round number.

There is, then, a schematic recurrence of Venus glyphs in connection with those round numbers which are distinctly pertinent to Venus under

Correlation A. Is it fair or logical to ignore the issue which they present? The only excuse for so doing is that a considerable number of other dates with Venus classifiers are involved in cyclic rather than current data on Venus. These aberrant records will be taken up in due course.

In order that my readers may have the means of following the true places of Venus phenomena in this discussion I now place on record a

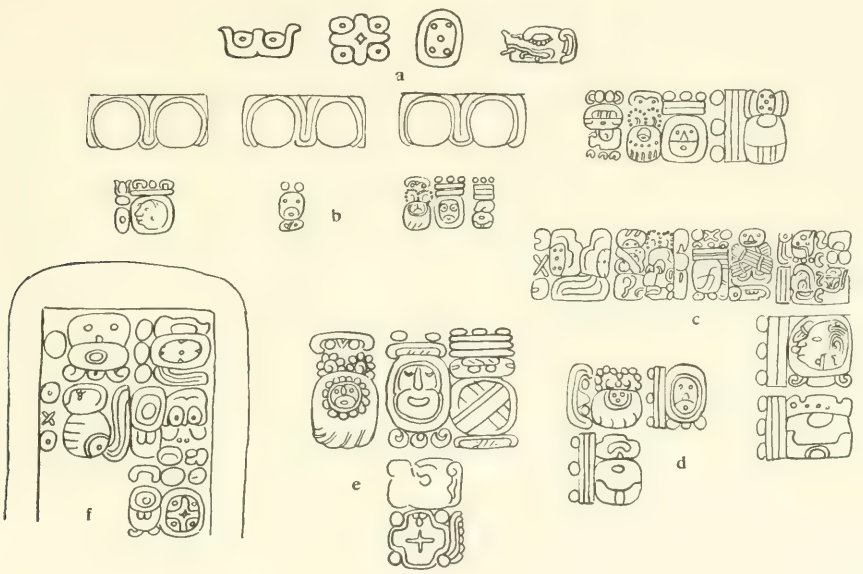


Fig. 13. Venus Records on Maya Monuments: *a*, four kinds of Venus glyphs; *b*, glyphs and dates in the Temple of Venus, Copan; *c*, part of the text on the Reviewing Stand, Copan; *d*, date on Altar Z, Copan; *e*, date on Altar S, Copan; *f*, date on Stela 12, Uaxactun.

tabulation from which the true places, sufficiently accurate for our purposes, may be obtained at a glance. Table XII is constructed upon determinations of the inferior conjunction of Venus by Willson. From his manuscript I have taken a sequence of 157 such conjunctions beginning in 392 A.D. and running to 643. Gregorian dates supplement the astronomical indices which are given in Julian days. Recurrences of the Venus phenomena are found on the same days in the years of horizontal rows. Differences of 251 years can be substituted by the more exact difference of 91675.44 days counting out from the central column of precise data. Heliacal settings and risings of Venus correspond in the Maya pattern to four days before and four days after the conjunction dates.

TABLE XII

INFERIOR CONJUNCTIONS OF VENUS IN THE 251 YEAR CYCLE

(Add or substract 91675.44 days for each lateral column for Julian days)

B.C.	B.C.	B.C.	A.D.	A.D.	Greg. Cal.	Julian Day	A.D.	A.D.	A.D.	A.D.
612	361	110	141	392	Dec. 3	1,864,572.6	643	894	1145	1396
						581.4				
610	359	108	143	394	Jul. 8	1,865,154.0	645	896	1147	1398
						587.9				
608	357	106	145	396	Feb. 15	1,865,741.9	647	898	1149	1400
						579.9				
607	356	105	146	397	Sept. 17	1,866,321.8	648	899	1150	1401
						586.5				
605	354	103	148	399	Apr. 27	1,866,908.3	650	901	1152	1403
						583.8				
604	353	102	149	400	Dec. 1	1,867,492.1	651	902	1153	1404
						581.6				
602	351	100	151	402	Jul. 5	1,868,073.7	653	904	1155	1406
						587.6				
600	349	98	153	404	Feb. 13	1,868,661.5	655	906	1157	1408
						579.9				
599	348	97	154	405	Sept. 15	1,869,241.4	656	907	1158	1409
						586.6				
597	346	95	156	407	Apr. 25	1,869,828.0	658	909	1160	1411
						583.7				
596	345	94	157	408	Nov. 28	1,870,411.7	659	910	1161	1412
						581.7				
594	343	92	159	410	Jul. 3	1,870,993.4	661	912	1163	1414
						587.7				
592	341	90	161	412	Feb. 11	1,871,581.1	663	914	1165	1416
						579.8				
591	340	89	162	413	Sept. 12	1,872,160.9	664	915	1166	1417
						586.8				
589	338	87	164	415	Apr. 22	1,872,747.7	666	917	1168	1419
						583.5				
588	337	86	165	416	Nov. 26	1,873,331.2	667	918	1169	1420
						581.9				
586	335	84	167	418	Jul. 1	1,873,913.1	669	920	1171	1422
						587.6				
584	333	82	169	420	Feb. 8	1,874,500.7	671	922	1173	1424
						579.8				
583	332	81	170	421	Sept. 10	1,875,080.5	672	923	1174	1425
						587.0				
581	330	79	172	423	Apr. 20	1,875,667.5	674	925	1176	1427
						583.2				
580	329	78	173	424	Nov. 23	1,876,250.7	675	926	1177	1428
						581.9				
578	327	76	175	426	Jun. 28	1,876,832.6	677	928	1179	1430
						587.6				
576	325	74	177	428	Feb. 6	1,877,420.2	679	930	1181	1432
						579.9				
575	324	73	178	429	Sept. 8	1,878,000.1	680	931	1182	1433
						586.5				
573	322	71	180	431	Apr. 17	1,878,586.6	682	933	1184	1435
						583.6				
572	321	70	181	432	Nov. 21	1,879,170.2	683	934	1185	1436
						581.8				
570	319	68	183	434	Jun. 26	1,879,752.0	685	936	1187	1438
						587.8				
568	317	66	185	436	Feb. 3	1,880,339.8	687	938	1189	1440
						579.6				
567	316	65	186	437	Sept. 5	1,880,919.4	688	939	1190	1441
						586.8				
565	314	63	188	439	Apr. 15	1,881,506.2	690	941	1192	1443
						583.5				

TABLE XII—Continued

Inferior Conjunctions of Venus in the 251 Year Cycle

(Add or substract 91675.44 days for each lateral column for Julian days)

B.C.	B.C.	B.C.	A.D.	A.D.	Greg. Cal.	Julian Day	A.D.	A.D.	A.D.	A.D.
564	313	62	189	440	Nov. 18	1,882,089.7	691	942	1193	1444
						582.0				
562	311	60	191	442	Jun. 23	1,882,671.7	693	944	1195	1446
						587.6				
560	309	58	193	444	Feb. 1	1,883,259.3	695	946	1197	1448
						580.1				
559	308	57	194	445	Sept. 3	1,883,839.4	696	947	1198	1449
						586.8				
557	306	55	196	447	Apr. 13	1,884,426.2	698	949	1200	1451
						583.0				
556	305	54	197	448	Nov. 16	1,885,009.2	699	950	1201	1452
						582.4				
554	303	52	199	450	Jun. 21	1,885,591.6	701	952	1203	1454
						587.4				
552	301	50	201	452	Jan. 30	1,886,179.0	703	954	1205	1456
						579.9				
551	300	49	202	453	Aug. 31	1,886,758.9	704	955	1206	1457
						586.9				
549	298	47	204	455	Apr. 10	1,887,345.8	706	957	1208	1459
						583.0				
548	297	46	205	456	Nov. 13	1,887,928.8	707	958	1209	1460
						582.5				
546	295	44	207	458	Jun. 19	1,888,511.3	709	960	1211	1462
						587.2				
544	293	42	209	460	Jan. 27	1,889,098.5	711	962	1213	1464
						580.0				
543	292	41	210	461	Aug. 29	1,889,678.5	712	963	1214	1465
						587.0				
541	290	39	212	463	Apr. 8	1,890,265.5	714	965	1216	1467
						582.8				
540	289	38	213	464	Nov. 11	1,890,848.3	715	966	1217	1468
						582.7				
538	287	36	215	466	Jun. 17	1,891,431.0	717	968	1219	1470
						587.1				
536	285	34	217	468	Jan. 25	1,892,018.1	719	970	1221	1472
						579.9				
535	284	33	218	469	Aug. 27	1,892,598.0	720	971	1222	1473
						587.2				
533	282	31	220	471	Apr. 6	1,893,185.2	722	973	1224	1475
						582.6				
532	281	30	221	472	Nov. 8	1,893,767.8	723	974	1225	1476
						582.9				
530	279	28	223	474	Jun. 14	1,894,350.7	725	976	1227	1478
						586.9				
528	277	26	225	476	Jan. 22	1,894,937.6	727	978	1229	1480
						579.9				
527	276	25	226	477	Aug. 24	1,895,517.5	728	979	1230	1481
						587.4				
525	274	23	228	479	Apr. 3	1,896,104.9	730	981	1232	1483
						582.4				
524	273	22	229	480	Nov. 7	1,896,687.3	731	982	1233	1484
						583.1				
522	271	20	231	482	Jun. 12	1,897,270.4	733	984	1235	1486
						586.8				
520	269	18	233	484	Jan. 20	1,897,857.2	735	986	1237	1488
						579.9				
519	268	17	234	485	Aug. 22	1,898,437.1	736	987	1238	1489
						587.5				
517	266	15	236	487	Apr. 1	1,899,024.6	738	989	1240	1491
						582.2				

TABLE XII—CONTINUED

INFERIOR CONJUNCTIONS OF VENUS IN THE 251 YEAR CYCLE

(Add or substract 91675.44 days for each lateral column for Julian days)

B.C.	B.C.	B.C.	A.D.	A.D.	Greg. Cal.	Julian Day	A.D.	A.D.	A.D.	A.D.
516	265	14	237	488	Nov. 3	1,899,606.8	739	990	1241	1492
						583.3				
514	263	12	239	490	Jun. 10	1,900,190.1	741	992	1243	1494
						586.6				
512	261	10	241	492	Jan. 18	1,900,776.7	743	994	1245	1496
						580.0				
511	260	9	242	493	Aug. 19	1,901,356.7	744	995	1246	1497
						587.5				
509	258	7	244	495	Mar. 30	1,901,944.2	746	997	1248	1499
						582.1				
508	257	6	245	496	Nov. 1	1,902,536.3	747	998	1249	1500
						583.4				
506	255	4	247	498	Jun. 7	1,903,109.7	749	1000	1251	1502
						586.6				
504	253	2	249	500	Jan. 16	1,903,696.3	751	1002	1253	1504
						579.7				
503	252	1	250	501	Aug. 18	1,904,276.0	752	1003	1254	1505
		A.D.				587.9				
501	250	1	252	503	Mar. 28	1,904,863.9	754	1005	1256	1507
						581.9				
500	249	2	253	504	Oct. 30	1,905,445.8	755	1006	1257	1508
						583.4				
498	247	4	255	506	Jun. 6	1,906,029.2	757	1008	1259	1510
						586.7				
496	245	6	257	508	Jan. 13	1,906,615.9	759	1010	1261	1512
						580.3				
495	244	7	258	509	Aug. 16	1,907,196.2	760	1011	1262	1513
						587.4				
493	242	9	260	511	Mar. 26	1,907,783.6	762	1013	1264	1515
						581.7				
492	241	10	261	512	Oct. 28	1,908,365.3	763	1014	1265	1516
						583.4				
490	239	12	263	514	Jun. 3	1,908,948.7	765	1016	1267	1518
						586.8				
488	237	14	265	516	Jan. 11	1,909,535.5	767	1018	1269	1520
						580.0				
487	236	15	266	517	Aug. 13	1,910,115.5	768	1019	1270	1521
						587.8				
485	234	17	268	519	Mar. 24	1,910,703.3	770	1021	1272	1523
						581.5				
484	233	18	269	520	Oct. 25	1,911,284.9	771	1022	1273	1524
						583.7				
482	231	20	271	522	Jun. 1	1,911,868.5	773	1024	1275	1526
						586.6				
480	229	22	273	524	Jan. 9	1,912,455.1	775	1026	1277	1528
						580.0				
479	228	23	274	525	Aug. 11	1,913,035.1	776	1027	1278	1529
						587.9				
477	226	25	276	527	Mar. 22	1,913,623.0	778	1029	1280	1531
						581.4				
476	225	26	277	528	Oct. 23	1,914,204.4	779	1030	1281	1532
						583.9				
474	223	28	279	530	May 30	1,914,788.3	781	1032	1283	1534
						586.4				
472	221	30	281	532	Jan. 6	1,915,374.7	783	1034	1285	1536
						580.0				
471	220	31	282	533	Aug. 8	1,915,954.7	784	1035	1286	1537
						588.0				
469	218	33	284	535	Mar. 19	1,916,542.7	786	1037	1288	1539
						581.2				

TABLE XII—Continued

Inferior Conjunctions of Venus in the 251 Year Cycle

(Add or substract 91675.44 days for each lateral column for Julian days)

B.C.	B.C.	A.D.	A.D.	A.D.	Greg. Cal.	Julian Day	A.D.	A.D.	A.D.	A.D.
468	217	34	285	536	Oct. 20	1,917,123.9	787	1038	1289	1540
						584.1				
466	215	36	287	538	May 28	1,917,708.0	789	1040	1291	1542
						586.2				
464	213	38	289	540	Jan. 4	1,918,294.2	791	1042	1293	1544
						580.0				
463	212	39	290	541	Aug. 6	1,918,874.2	792	1043	1294	1545
						588.1				
461	210	37	292	543	Mar. 17	1,919,462.3	794	1045	1296	1547
						581.1				
460	209	38	293	544	Oct. 18	1,920,043.4	795	1046	1297	1548
						584.3				
458	207	40	295	546	May 25	1,920,627.7	797	1048	1299	1550
						586.1				
457	206	41	296	547	Jan. 1	1,921,213.8	798	1049	1300	1551
						580.1				
455	204	43	298	549	Aug. 3	1,921,793.9	800	1051	1302	1553
						588.0				
453	202	45	300	551	Mar. 14	1,922,381.9	802	1053	1304	1555
						581.1				
452	201	50	301	552	Oct. 16	1,922,963.0	803	1054	1305	1556
						584.4				
450	199	52	303	554	May 23	1,923,547.4	805	1056	1307	1558
						585.9				
449	198	53	304	555	Dec. 30	1,924,133.3	806	1057	1308	1559
						580.3				
447	196	55	306	557	Aug. 1	1,924,713.6	808	1059	1310	1561
						588.0				
445	194	57	308	559	Mar. 12	1,925,301.6	810	1061	1312	1563
						580.9				
444	193	58	309	560	Oct. 13	1,925,882.5	811	1062	1313	1564
						584.7				
442	191	60	311	562	May 21	1,926,467.2	813	1064	1315	1566
						585.6				
441	190	61	312	563	Dec. 27	1,927,052.8	814	1065	1316	1567
						580.5				
439	188	63	314	565	Jul. 30	1,927,633.3	816	1067	1318	1569
						587.9				
437	186	65	316	567	Mar. 10	1,928,221.2	818	1069	1320	1571
						580.8				
436	185	66	317	568	Oct. 11	1,928,802.0	819	1070	1321	1572
						584.9				
434	183	68	319	570	May 18	1,929,386.9	821	1072	1323	1574
						585.5				
433	182	69	320	571	Dec. 25	1,929,972.4	822	1073	1324	1575
						580.6				
431	180	71	322	573	Jul. 28	1,930,553.0	824	1075	1326	1577
						587.9				
429	178	73	324	575	Mar. 7	1,931,140.9	826	1077	1328	1579
						580.6				
428	177	74	325	576	Oct. 8	1,931,721.5	827	1078	1329	1580
						585.2				
426	175	76	327	578	May 16	1,932,306.7	829	1080	1331	1582
						585.2				
425	174	77	328	579	Dec. 22	1,932,891.9	830	1081	1332	1583
						580.7				
423	172	79	330	581	Jul. 25	1,933,472.6	832	1083	1334	1585
						587.8				
421	170	81	332	583	Mar. 5	1,934,060.4	834	1085	1336	1587
						580.6				

TABLE XII—Continued

Inferior Conjunctions of Venus in the 251 Year Cycle

(Add or substract 91675.44 days for each lateral column for Julian days)

B.C.	B.C.	A.D.	A.D.	A.D.	Greg. Cal.	Julian Day	A.D.	A.D.	A.D.	A.D.
420	169	82	333	584	Oct. 6	1,934,641.0	835	1086	1337	1588
						585.4				
418	167	84	335	586	May 14	1,935,226.4	837	1088	1339	1590
						585.0				
417	166	85	336	587	Dec. 20	1,935,811.4	838	1089	1340	1591
						580.8				
415	164	87	338	589	Jul. 23	1,936,392.2	840	1091	1342	1593
						588.0				
413	162	89	340	591	Mar. 3	1,936,980.2	842	1093	1344	1595
						580.4				
412	161	90	341	592	Oct. 3	1,937,560.6	843	1094	1345	1596
						585.5				
410	159	92	343	594	May 12	1,938,156.1	845	1096	1347	1598
						584.8				
409	158	93	344	595	Dec. 17	1,938,730.9	846	1097	1348	1599
						580.9				
407	156	95	346	597	Jul. 20	1,939,311.8	848	1099	1350	1601
						588.0				
405	154	97	348	599	Feb. 28	1,939,899.8	850	1101	1352	1603
						580.3				
404	153	98	349	600	Oct. 1	1,940,480.1	851	1102	1353	1604
						585.7				
402	151	100	351	602	May 10	1,941,065.8	853	1104	1355	1606
						584.7				
401	150	101	352	603	Dec. 16	1,941,650.5	854	1105	1356	1607
						580.9				
399	148	103	354	605	Jul. 19	1,942,231.4	856	1107	1358	1609
						588.0				
397	146	105	356	607	Feb. 27	1,942,819.4	858	1109	1360	1611
						580.3				
396	145	106	357	608	Sept. 29	1,943,399.7	859	1110	1361	1612
						585.8				
394	143	108	359	610	May 8	1,943,985.5	861	1112	1363	1614
						584.5				
393	142	109	360	611	Dec. 14	1,944,570.0	862	1113	1364	1615
						581.1				
391	140	111	362	613	Jul. 17	1,945,151.1	864	1115	1366	1617
						587.9				
389	138	113	364	615	Feb. 25	1,945,739.0	866	1117	1368	1619
						580.2				
388	137	114	365	616	Sept. 27	1,946,319.2	867	1118	1369	1620
						596.0				
386	135	116	367	618	May 6	1,946,905.2	869	1120	1371	1622
						584.3				
385	134	117	368	619	Dec. 11	1,947,489.5	870	1121	1372	1623
						581.2				
383	132	119	370	621	Jul. 14	1,948,070.7	872	1123	1374	1625
						587.9				
381	130	121	372	623	Feb. 22	1,948,658.6	874	1125	1376	1627
						580.2				
380	129	122	373	624	Sept. 23	1,949,238.8	875	1126	1377	1628
						586.1				
378	127	124	375	626	May 4	1,949,824.9	877	1128	1379	1630
						584.2				
377	126	125	376	627	Dec. 9	1,950,409.1	878	1129	1380	1631
						581.2				
375	124	127	378	629	Jul. 12	1,950,990.3	880	1131	1382	1633
						587.9				
373	122	129	380	631	Feb. 20	1,951,578.2	882	1133	1384	1635
						580.1				

TABLE XII—Continued

Inferior Conjunctions of Venus in the 251 Year Cycle

(Add or substract 91675.44 days for each lateral column for Julian days)

B.C.	B.C.	A.D.	A.D.	A.D.	Greg. Cal.	Julian Day	A.D.	A.D.	A.D.	A.D.
372	121	130	381	632	Sept. 22	1,952,158.3	883	1134	1385	1636
						586.4				
370	119	132	383	634	May 1	1,952,744.7	885	1136	1387	1638
						583.9				
369	118	133	384	635	Dec. 6	1,953,328.6	886	1137	1388	1639
						581.4				
367	116	135	386	637	Jul. 10	1,953,910.0	888	1139	1390	1641
						587.9				
365	114	137	388	639	Feb. 17	1,954,497.9	890	1141	1392	1643
						579.9				
364	113	138	389	640	Sept. 19	1,955,077.8	891	1142	1393	1644
						586.5				
362	111	140	391	642	Apr. 29	1,955,664.3	893	1144	1395	1646
						583.8				
361	110	141	392	643	Dec. 4	1,956,248.1	894	1145	1396	1647

The Venus Table of the Dresden Codex. It is generally admitted that the Venus Table of the Dresden Codex is formed on mean synodical revolutions of the planet fixed at 584 days although single revolutions as observed in the heavens may be as much as 588 days or as little as 579.9 days with a true mean at 583.92 days. The Venus Calendar of the Mayas rests on an early discovery that five Venus years at 584 days are equal to eight vague solar years at 365 days. When these numerical elements are counted in a permutation with the tzolkin the least common multiple is found at 37960, exactly two ordinary calendar rounds.

The Venus Table differs from the lunar one in providing month places for tzolkin days of the various phenomena of the planet. The four recorded phases or stations of Venus are separated by 236 days (duration as morning star); 90 days (obscuration at superior conjunction); 250 days (duration as evening star); and 8 days (obscuration at inferior conjunction). The Venus Table is displayed on five pages of the ancient manuscript, each page being divided vertically, with the calendarial matter written on the left and with ruling deities, warring deities and victims pictured on the right.

First, in the upper left hand part of each page are four columns of day signs, each column having the same sign, but the numerical elements of these signs change schematically. The intervals between the columns are 90, 236, 250 and 8 days as explained above. For each column a single month position suffices, making twenty in all for the five pages in a complete pattern. But the mechanism emphasizes the month position under the last column on each page which gives the heliacal rising of the planet in the phase of morning star. Any row of day signs when counted across the five pages covers $5 \times 584 = 2920$ days. Thirteen rows, across all five pages, recover the same day with the same month position.

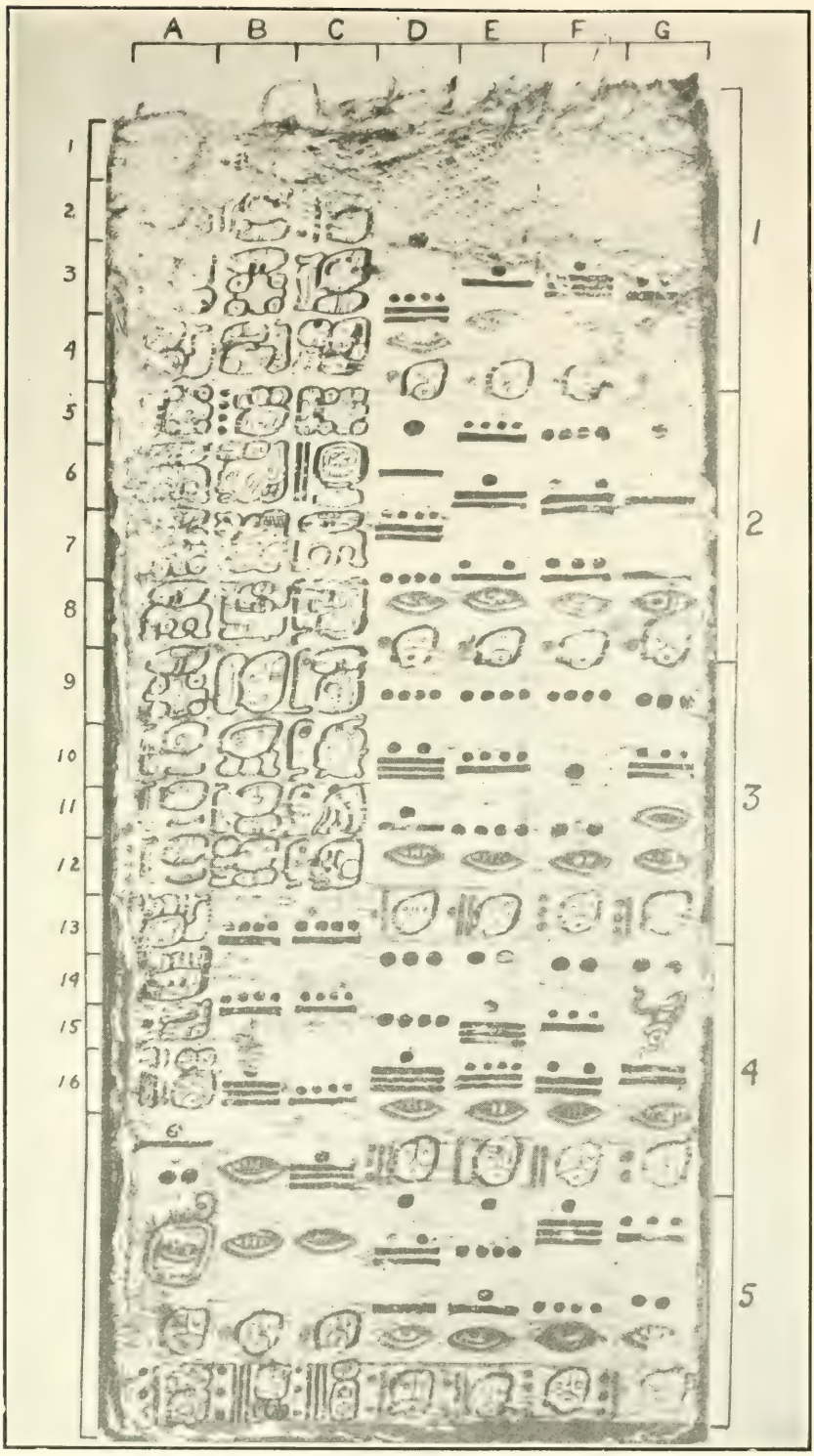


Plate II. Page 24 of the Dresden Codex.

	A	B	C	D	E	F	G	
1	Hieroglyphs			1 1 1 14 0 1 Ahau	15 16 6 0 1 Ahau	10 10 16 0 1 Ahau	5 5 8 0 1 Ahau	1
2				1 5 14 4 0 1 Ahau	9 11 7 0 1 Ahau	4 12 8 0 1 Ahau	1 5 5 0 1 Ahau	2
3				4 17 6 0 6 Ahau	4 9 4 0 11 Ahau	4 1 2 0 3 Ahau	3 13 0 0 8 Ahau	3
4		9 9 16 0 1 Ahau 18 Kayab	9 9 9 16 1 Ahau 18 Uo	3 4 16 0 13 Ahau	2 16 14 0 5 Ahau	2 8 12 0 10 Ahau	2 0 10 0 2 Ahau	4
5	6 2 0 4 Ahau 8 Cumhu			1 12 5 [8] 0 7 Ahau	1 4 6 0 12 Ahau	16 4 0 4 Ahau	8 2 0 9 Ahau	5

	A	B	C	D	E	F	G	
1	Hieroglyphs			151,840 1 Ahau	113,880 1 Ahau	75,920 1 Ahau	37,960 1 Ahau	1
2				185,120 1 Ahau	68,900 1 Ahau	33,280 1 Ahau	9,100 1 Ahau	2
3				35,040 6 Ahau	32,120 11 Ahau	29,200 3 Ahau	26,280 8 Ahau	3
4	2,200	1,366,560 1 Ahau 18 Kayab	1,364,360 1 Ahau 18 Uo	23,360 13 Ahau	20,440 5 Ahau	17,520 10 Ahau	14,600 2 Ahau	4
5	4 Ahau 8 Cumhu			11,680 7 Ahau	8,760 12 Ahau	5,840 4 Ahau	2,920 9 Ahau	5

Plate III. Diagram showing reduction in two stages of dates and numbers on Page 24 of the Dresden Codex.

As a matter of fact the Venus Table gives three independent sets of month positions for three complete calendarial set-ups, the beginnings being disclosed at the bottom of the last column of days where 1 Ahau is declared and at the end of the three rows of month signs where we find 13 Mac, 18 Kayab and 3 Xul. These are convertible into 1 Ahau 13 Mac, 1 Ahau 18 Kayab and 1 Ahau 3 Xul, these being dates of arrival and departure for the entire table of days.

Page 24 of the Dresden Codex is the preamble or introduction to this table and in the manuscript immediately precedes the extended permutation. I reproduce the page herewith in two plates taken from my *Ancient Civilizations of Mexico and Central America*—the first being photographic and the second analytic, transcribing and reducing the numbers. The block of forty hieroglyphs in the upper left hand part of the page displays the single or double form of the Venus hieroglyph no less than eight times, generally in combination with symbols which are believed to mean the colors of the four world quarters.

Below this section of the hieroglyphs are three numbers and three calendar round dates. The first number on the right is actually the difference between the other two. The first date applies to the second number which is exactly equal to 72 calendar rounds so that 4 Ahau 8 Cumhu of the Mundane Era is reached by it. The second date, 1 Ahau 18 Kayab, is reached by the third number (or by the second number less the first) and the third date, 1 Ahau 18 Uo, has no number of its own but places in the Long Count can be found for it by using some of the intervals recorded in the four columns of numbers on the right side of this page. Here nearly all the numbers are parts of a multiplication table, but a few have special properties.

The first number in the lower right hand corner is 2920 (5 x 584 and 8 x 365), the short Venus period. It is counted from a suppressed 1 Ahau and reaches a recorded 9 Ahau. All the multiples of 2920 up to the twelfth are given in the lower three rows, the count increasing in each row toward the left, and in G1 is written the thirteenth multiple which completes the permutation and recovers 1 Ahau: this is 37960 which, as we have seen, equals 65 Venus revolutions formalized at 584 days each or 104 Maya years. Next in the remaining spaces of the top row we find 37960 taken two, three and four times, the last multiple equalling 260 Venus revolutions of the formal kind, or 416 Maya years Although partly erased these numbers have been restored with assurance.

In row two are four other numbers which are not intervals of the formal Venus pattern. These are 9100, 33280, 68900 and 185120. First we must note that all of them contain 260 without a remainder and therefore recover any tzolkin designation, for instance, 1 Ahau, from which they are counted. Indeed all of them are written with 1 Ahau

as much as to imply that they should be used with patterns of the Venus Calendar which also depart from and arrive at 1 Ahau. It seems proper to use these numbers, in our search for a solution, else why were they placed here invitingly by the Maya scribe?

Now two of the four numbers in the series are close proximations to 57 and 118 revolutions of Venus at mean values for the revolution. The second and third numbers (F2 and E2) reduce to the following comparisons:

$$57 \times 583.92 = 33283.44 \text{ days or } 3.44 \text{ more than } 33280 \text{ days}$$

$$118 \times 583.92 = 68902.56 \text{ days or } 2.56 \text{ more than } 68900 \text{ days}$$

Since 65 mean revolutions of Venus are 5.2 days less than the formal calendar round while these numbers have an error of an opposite nature it follows that they can be added to calendar rounds in such a fashion as to give rather accurate totals for large groups of Venus years. That the Mayas themselves combined the numbers is shown by the fact that 185120, the largest of the four under discussion, is precisely $4 \times 27960 = 151840$ (D1) plus 33280 (F1). Also the dates 1 Ahau 13 Mac, 1 Ahau 18 Kayab and 1 Ahau 3 Xul, already defined as points of departure and arrival for Venus calendarial patterns, can be connected with each other by these numbers in a scale of true Venus intervals, as can 1 Ahau 18 Uo. For instance:

1 Ahau 18 Kayab	+ 68900	= 1 Ahau 13 Mac
1 Ahau 18 Kayab	+ 33280	= 1 Ahau 18 Uo
1 Ahau 18 Uo	+ 33280	= 1 Ahau 3 Xul

Before we attempt to place these calendar round statements where they will correspond to the true places of Venus let us look a bit deeper into the properties of 33280 and 68900. It appears that they owe their efficiency as balancing agents in Venus calculations to a smaller number, namely 2340 which is concealed, as it were, in their construction. This number is 4.32 days in excess of four mean revolutions of Venus and when subtracted from the round of the Venus calendar, which is 5.20 days in excess of 65 mean revolutions, produces a rather close balance:

65 mean revolutions	+ 5.20 days	= 37960 days
4 " "	+ 4.32 "	= 2340 "
61 " "	+ .88 "	= 35620 "

F2 and E2 are derived in the same way by the subtraction of a multiple of 2340 from one or more rounds of the Venus calendar.

F 2			E 2		
37960		5.20 days	75920 (2 x 37960)		10.40 days
4680 (2 x 2340)		8.64 "	6920 (3 x 2340)		12.96 "
33280	—	3.44 "	68900	—	2.56 "

The reader will recognize 4680, reached by doubling 2340, as an

important eclipse interval. With it the Mayas could also effect certain coördinations between eclipses and phenomena of Venus. They were not restricted to this interval in their interplanetary adjustments. The short period of Venus ($8 \times 365 = 2920$ days) is 3.53 days less than 99 lunations and therefore could have been employed during the First Empire to connect the true and the cyclic phases of the moon when the recession of the former ranged from 3 to 4 days. Also the formal Lunar Calendar of 11960 days has the property of connecting significant positions in the Venus Calendar, as appears from the fact that 1 Ahau 18 Kayab plus 11960 days = 1 Ahau 13 Mac. Moreover, 11960 days plus three ordinary calendar rounds = 68900, our number in E2. The number 9100 in G2 may also have something to do with the interrelation of Venus and the moon. When this number is added to the basic date recorded on page 24 of the codex we obtain:

9- 9- 9-16- 0, 1 Ahau 18 Kayab,	Apr. 12, 363 A.D.
1- 5- 5- 0	
9-10-15- 3- 0, 1 Ahau 13 Pax,	Mar. 14, 388 A.D.

This second date is a full moon and perhaps the Mayas thought it was a lunar eclipse syzygy, a condition which it just misses according to Oppolzer's Canon. The explanation is attractive on several scores. The date is 60 days after 9-10-15- 0- 0, 6 Ahau 13 Muan, Jan. 11, 388, which is itself prominent in lunar calculations at Copan. It falls between 1 Ahau 18 Kayab and 1 Ahau 13 Mac, both cyclic full moons separated by 11960, as follows:

9– 9– 9–16– 0, 1 Ahau 18 Kayab,	Apr. 12, 363 A.D.
1–13– 4– 0	One lunar eclipse cycle
9–11– 3– 2– 0, 1 Ahau 13 Mac,	Jan. 9, 396

We have seen that the Initial Series of the Temple of the Foliated Cross at Palenque locates 1 Ahau 13 Mac just two Grand Cycles earlier where it occupies the same place in the tropical year; that is:

1–18– 5– 4– 0, 1 Ahau 13 Mac,	Jan. 8, 2618 B.C.
7–12–17–16– 0	
9–11– 3– 2– 0, 1 Ahau 13 Mac,	Jan. 9, 396 A.D.

But neither 1 Ahau 18 Kayab in 363 A.D. nor 1 Ahau 13 Mac in 396 A.D. coincide with heliacal risings of Venus according to either Correlation A or B. Fortunately the Dresden Codex itself furnishes us with a place where the 1 Ahau 18 Kayab layout functions in conformity with current phenomena of Venus under the terms of Correlation A. This is the date 10-19- 6- 1- 0, 4 Ahau 18 Kayab, Nov. 20, 950 A.D., which strikes as it should exactly four days after inferior conjunction of the planet. We have already discussed this date in relation to the moon for it occurs in the preamble to the Lunar Table and is reached by subtracting a declared 8 days from 12 Lamat 6 Cumhu. This 12 Lamat

6 Cumhu fell four days before a lunar eclipse and a double tzolkin before the first member of the solar eclipse series on 12 Lamat.

As for 1 Ahau 13 Mac, it can be carried forward by Venus calendar rounds from cyclic positions to coinciding positions:

1–18– 5– 4– 0, 1 Ahau 13 Mac, Jan. 8, 2618 B.C. Cyclic position, Palenque
7–12–17–16– 0 29 rounds of the Venus calendar
9–11– 3– 2– 0, 1 Ahau 13 Mac, Jan. 9, 396 A.D. Cyclic position, Dresden Codex
1– 1– 1–14– 0 4 rounds of the Venus Calendar (D1)
10–12– 4–16– 0, 1 Ahau 13 Mac, Oct. 2, 811 A.D.
15–16– 6– 0 3 rounds of Venus calendar (E1)
11– 8– 1– 4– 0, 1 Ahau 13 Mac, July 17, 1123 A.D. Inferior conjunction + 2 days
5– 5– 8– 0 1 round of the Venus calendar (G1)
11–13– 6–12– 0, 1 Ahau 13 Mac, June 21, 1227 A. D. Inferior conjunction + 7 days

I have already shown[1] that Quetzalcoatl calculated an heliacal rising of Venus on the Mexican day 1 Acatl in 1208. This date fits exactly into the 1 Ahau 13 Mac calendar.

The Grand Cycle and the Venus Calendar. Five places in the Maya year and five places in the tropical or Gregorian year are emphasized as real or cyclic places of Venus. Those in the Maya year are the places indicated for heliacal risings in the calendarial pattern which departs from 1 Ahau 18 Kayab. I put 19 Xul in the lead instead of 18 Kayab, so the order becomes: 19 Xul, 18 Kayab, 12 Yax, 6 Zip, and 5 Kankin. Although really 584 days apart these are reducible to the compass of a single year where they seem to be 73 days apart. The real sequence is reached by a turn of one and three-fifths of the circle of the year from the next place.

The five places in the Gregorian year have a similar relationship to each other and depart from April 12 which is disclosed by Correlation A as the Gregorian date of 9- 9- 9-16-0, 1 Ahau 18 Kayab, Apr. 12, 363 A.D. The five Venus dates in the Gregorian year are April 12, November 16, June 23, January 28 and September 3. Here the variability of the Gregorian intercalation allows a slight leeway and it seems as if the third date were to be identified with the summer solstice and the first and fourth dates with places reached by sunset readings along lines of observation at Copan.

As may be seen from our Table XII, heliacal risings of Venus return to the same day of the tropical year after 251 years.[2]

That is, the phenomena recede 73 days or one-fifth of a year so that a series of new coincidences are formed at the very five points on a circle of the tropical year where heliacal risings had taken place just 251 years

[1] Spinden, 1928 a, p. 58.

[2] A slightly less accurate cycle is 243 years, which is handled on Stela C at Copan. The formulae are:

$243 \times 365.2422 = 88753.85$ days: $152 \times 583.92 = 88755.84$ days: diff. 1.99 days
$251 \times 365.2422 = 91675.79$ days: $157 \times 583.92 = 91675.44$ days: diff. .34 days

before. In other words, the heliacal rising that was at A will recede in 251 years to D and the heliacal rising at C will move to A, etc.

But the change of placement in the Maya vague year is only about 12 days, for the vague year itself recedes 61 days, and 73 less 61 are 12 days. It is apparent that an approximate overcycle serving both the vague and tropical years will be formed on six placements of the Venus pattern in 6 x 251 = 1506 years. This is so near the Grand Cycle of 1507 years that month positions of heliacal risings of Venus in both the Maya and Gregorian years return to practical conformity while the tzolkin designations are one year in arrears. To be sure there is an error on Venus of 2.04 days which must either be neglected or wiped out by counting backward one eight-year period and upsetting the general conformity. The six calendarial patterns which result from these considerations are shown in Table XIII, arranged under the five places in the tropical year mentioned above.

TABLE XIII

SIX VENUS CALENDARS COORDINATED WITH TRUE YEARS

	Apr. 12	Nov. 16	June 23	Jan. 28	Sept. 3
A	19 Xul	**18 Kayab***	12 Yax	6 Zip	5 Kankin
B	0 Yax	14 Uo	**13 Mac***	7 Xul	6 Kayab
C	1 Mac	15 Tzec	14 Pax	**8 Chen***	2 Uo
D	2 Pax	16 Mol	10 Pop	9 Ceh	**3 Tzec***
E	**3 Uayeb***	17 Zac	11 Zotz	10 Muan	4 Mol
F	19 Zip	**18 Kankin***	12 Yaxkin	11 Cumhu	5 Zac

We have already seen that Calendar A is placed for us on page 52a of the Dresden Codex at 10-19-6-1-0, 4 Ahau 18 Kayab, Nov. 20, 950 A.D. This engagement is two short periods of Venus before a 7 Ahau 18 Kayab which coincides precisely with November 16. From this last position we may subtract 29 calendar rounds less one year, that is 3-16-7-16-15 or 550055 days, as follows, and find another coincidence with phenomena of Venus:

11– 0– 2– 5– 0, 7 Ahau 18 Kayab[1], Nov. 16, 966 A.D. Heliacal Rising of Venus
3–16– 7–16–15,
7– 3–14– 7, 5 8 Chicchan 18 Kayab, Nov. 16, 540 B.C. Heliacal Rising of Venus

This gives what I term an inaugural setting of the Venus calendar on the theory that the ceremonial count took definite form in the sixth century before Christ. The tzolkin had already been evolved out of the analysis of eclipse intervals and was then applied by Maya astronomers to the appearances of Venus. According to my calculation the heliacal rising four days after inferior conjunction fell on 9 Cimi 19 Kayab, November 17, 540 B.C. or about one day out of the formal pattern of the Venus calendar. I summarize a typical set of five heliacal risings in adjustment with formal places of Calendar A at the supposed time of inauguration.

*On Table XIII, regent dates following 1 Ahau 18 Kayab are emphasized. These are only the ones that also fit into the 251 year scheme.

TABLE XIV

RECONSTRUCTED INAUGURAL CONDITIONS OF THE VENUS CALENDAR

Heliacal Risings of Venus		Formal Calendar	
7– 3–12–13– 4, 12 Kan 2 Yaxkin,	Apr. 15, 541 B.C.	19 Xul	Apr. 12
1–11– 2 (582.4 days)			
7– 3–14– 6– 6, 9 Cimi 19 Kayab,	Nov. 17, 540	18 Kayab	Nov. 16
1–11– 3 (583.1 days)			
7– 3–15–17– 9, 7 Muluc 12 Yax	June 23, 538	12 Yax	June 23
1–11– 7 (586.6 days)			
7– 3–17–10–16, 9 Cib 9 Zip,	Jan. 30, 536	6 Zip	Jan. 28
1–11– 0 (581.1 days)			
7– 3–19– 5–16, 4 Cib 4 Kankin,	Sept. 2, 535	5 Kankin	Sept. 3

Calendar B represents the conditions of recession in terms of Maya months when there is re-coincidence of heliacal risings 251 years after the above original organization of Calendar A. But the identical pattern of the Dresden Codex, characterized by 1 Ahau 13 Mac as regent date, functioned after another 1506 year cycle. Between a station of Calendar B on June 23, 1219 A. D. and a corresponding station of Calendar A on November 16, 966 A. D., the interval is 92260 whole days while 158 mean synodic revolutions of Venus are 92262.36 days. Calendars C to F of Table XIII are necessary to complete the cycle of 1506 years. Whether or not they were ever formally used is another question.

It is obvious that a smoothing out process is required to set a uniform interval of 584 days against a variety of astronomical intervals which may vary four days on either side of this and only strike with fair uniformity on the sixth beat. April 12 is three days out on Venus when 19 Xul and April 12 coincide in 541 B.C. yet we find cyclic reference to the date in the Dresden Codex, on Stela C at Copan and by reasonable inference on Stela A, while the last setting of the astronomical base line at Copan reaches this date, as does also the so-called Apotheosis of Quelzalcoatl in 1208. Stela 11 at Yaxchilan has a large Venus sign below the celestial canopy and one of the dates is 9-15-19-1-1, 1 Imix 19 Xul, Aug. 4, 490 A. D. Subtracting 10 rounds of the Venus calendar gives us 19 Xul on April 14 at a Venus coincidence eight years before the one chosen above. The real heliacal rising of Venus in 490 A. D. was 52 days in advance of the cyclic position. That is:

7– 3– 4–11– 1,	1 Imix 19 Xul, Apr. 14, 549 B.C.	Hel. Rising of Venus
2–12–14– 8– 0	(10 rounds of Venus Calendar)	
9–15–19– 1– 1	1 Imix 19 Xul, Aug. 4, 490 A.D.	Cyclic Date
2–12	(52 days recession in 10 rounds)	
9–15–18–16– 9,	1 Muluc 7 Zotz, June 13, 490 A.D.	Hel. Rising of Venus

The actual heliacal risings for the first and last dates are + 3 and — 1 days over the smoothed out calendar, and the mean rate of recession, but 1 Imix, the first day of the tzolkin, is achieved as a point of departure for a Venus count. Before going farther into the matter of cyclic dates of Venus, I wish to take up the 1 Ahau regent system which is pretty strongly implied in constructions of the Dresden Codex.

Regents of the Venus Calendar. Theoretically and over a long range of time all 73 varieties of 1 Ahau dates can be put in contact with true places of Venus as the bases of temporary calendars. Practically only 28 of these possibilities come into play during the 2,150 years of Maya history after 613 B.C. The order of these dates is found schematically by counting backward through the calendar round at the uniform rate of 2340 days, or the dates can be put in two series A and B, each with a recessional difference of 4680 days or 13 tuns. Real historical placement calls, of course, for forward counting, generally using the intervals recorded in E2 and F2 on page 24 of the Dresden Codex. Taking the 1 Ahau 18 Kayab and 1 Ahau 13 Mac calendarial patterns as points of departure the full set of regents is as follows:

TABLE XV

1 Ahau Regents of the Venus Calendar

Series A.

(1)	7– 0– 6– 4– 0, 4–12– 8– 0	1 Ahau 8 Kankin,	Sept. 23, 607 B.C.	7 days after Conj.	Inf.
(3)	7– 4–18–12– 0, 9–17–16– 0	1 Ahau 13 Kayab,	Nov. 4, 516	3 "	" " "
(5)	7–14–16–10– 0, 9–17–16– 0	1 Ahau 13 Uo,	Nov. 22, 321	3 "	" " "
(7)	8– 4–14– 8– 0, 9–17–16– 0	1 Ahau 18 Tzec,	Dec. 10, 126	3 "	" " "
(9)	8–14–12– 6– 9, 9–17–16– 0	1 Ahau 3 Chen,	Dec. 29, 69 A.D.	5 "	" " "
(11)	9– 4–10– 4– 0, 9–17–16– 0	1 Ahau 8 Ceh	Jan. 15, 265	4 "	" " "
(13)	9–14– 8– 2– 0, 4–12– 8– 0	1 Ahau 13 Muan,	Feb. 2, 460	6 "	" " "
(15)	9–19– 0–10– 0, 4–12– 8– 0	1 Ahau 13 Cumhu	Mar. 17, 551	3 "	" " "
(17)	10– 3–13– 0– 0, 4–12– 8– 0	1 Ahau 18 Zip,	Apr. 29, 642	0 "	" " "
(19)	10–13–10–16– 0, 9–17–16– 0	1 Ahau 3 Yaxkin,	May 16, 837	2 "	" " "
(21)	11– 3– 8–14– 0, 9–17–16– 0	1 Ahau 8 Yax,	June 3, 1032	4 "	" " "
(23)	11–13– 6–12– 0, 9–17–16– 0	1 Ahau 13 Mac	June 21, 1227	7 "	" " "
(25)	12– 3– 4–10– 0, 4–12– 8– 0	1 Ahau 18 Pax,	July 9, 1422	7 "	" " "
(27)	12– 7–17– 0– 0,	1 Ahau 18 Pop,	Aug. 21, 1513	3 "	" " "

*This date may be moved forward one Venus calendar round

Series B

(2)	7– 0–12–13– 0, 4–12– 8– 0	1 Ahau 13 Zip,	Feb. 18, 600 B.C.	7 days after	Inf. Conj.
(4)	7– 5– 5– 3– 0, 4–12– 8– 0	1 Ahau 18 Xul,	Apr. 4, 509	5 "	" " "
(6)	7– 9–17–11– 0, 9–17–16– 0	1 Ahau 3 Yax,	May 15, 418	3 "	" " "
(8)	7–19–15– 9– 0, 4–12– 8– 0	1 Ahau 8 Mac,	June 2, 223	4 "	" " "
(10)	8– 4– 7–17– 0 9–17–16– 0	1 Ahau 13 Pax,	July 13, 132	2 "	" " "
(12)	8–14– 5–15– 0, 9–17–16– 0	1 Ahau 13 Pop,	Aug. 2, 63 A.D.	4 "	" " "

(14)	9– 4– 3–13– 0, 9–17–16– 0	1 Ahau 18 Zotz,	Aug. 20, 238 A.D.	4 Days after Inf. Conj.	
(16)	9–14– 1–11– 0, 9–17–16– 0	1 Ahau 3 Mol,	Sept. 6, 453	5 " " " "	
(18)	10– 3–19– 9– 0, 4–12– 8– 0	1 Ahau 8 Zac,	Sept. 24, 648	6 " " " "	
(20)	10– 8–11–17– 0, 9–17–16– 0	1 Ahau 13 Kankin,	Nov. 7, 739	4 " " " "	
(22)	10–18– 9–15– 0, 9–17–16– 0	1 Ahau 18 Kayab,	Nov. 24, 934	3 " " " "	
(24)	11– 8– 7–13– 0, 9–17–16– 0	1 Ahau 18 Uo,†	Dec. 12, 1129	4 " " " "	
(26)	11–18– 5–11– 0, 9–17–16– 0	1 Ahau 3 Xul,‡	Dec. 29, 1324	5 " " " "	
(28)	12– 8– 3– 9– 0,	1 Ahau 8 Chen,	Jan. 17, 1520	4 " " " "	

†This regent is recorded on page 24 of the Dresden Codex.
‡This regent is the point of departure for the third row of month-positions in the Venus Calendar of the Dresden Codex.

Cyclic Dates in the Venus Calendar. The formal intervals of the Venus Calendar were applied cyclicly but whether according to one or several manners the evidence leaves room for doubt. We have seen that on Stela 11 at Yaxchilan a cyclic restatement from an heliacal rising on 1 Imix is carried forward ten rounds of the Venus calendar although in that time the recession of the phenomenon in the Maya year amounts to 52 days. But in other cases the cyclic character of Venus dates must rest upon a different concept. My own understanding of the evidence is that the five points of the inaugural setting both in the Maya year and the true tropical year had ceremonial importance especially when they fell on round numbers or in some other notable configuration. By this I mean that 19 Xul, 18 Kayab, 12 Yax, 6 Zip and 5 Kankin in any Maya year were colored by associations with the planet as were April 12, November 16, June 23, January 28 and September 3. Of course such fixed sets of sacred days would have been hailed by the priesthood as a working basis for ceremonialism, just as Easter and Christmas, let alone Sunday, are involved in the fabric of Christian ceremonialism.

The normal type of Venus glyph, i.e., the common "spectacled type," is seen as the title in six introducing glyphs to inscriptions of the First Empire. Also there are many other cases where the head of the Venus monster is used as the title but we will pay attention to these six of the spectacled type first. One of them occurs on Altar K at Copan and this Teeple said, "can likely mean only the end of a Venus year." Of course he was thinking of observed rather than cyclic years of Venus. He then proceeded to show that if the regent 1 Ahau 3 Yaxkin, were established at 9- 9-16- 7- 0, 1 Ahau 3 Yaxkin, the date on Altar K would be the end of the 37th Venus revolution. This supposition falls flat when all the dates similarly marked are compared with each other. I do this in Table XVI, first reducing the Maya numbers to Arabic numbers, and then obtaining a complete set of fifteen intervals by all possible subtractions. One of these is 579 days and the others are distributed along the line far from any possible direct association with Venus phenomena.

TABLE XVI

INITIAL SERIES WITH NORMAL VENUS SIGNS AS TITLES

A	Stela 24, Naranjo	9–12–10– 5–12,	4 Eb	10 Yax, Oct. 31, 422 A.D.
B	Altar K, Copan	9–12–16– 7– 8	3 Lamat	16 Yax, Nov. 5, 428
C	Lintel 29, Yaxchilan	9–13–17–12–10,	8 Oc	13 Yax, Oct. 27, 449
D	Stela 18, Naranjo	9–14–15– 0– 0,	11 Ahau	18 Zac, Nov. 17, 466
E	Stela K, Quirigua	9–18–15– 0– 0,	3 Ahau	3 Yax, Sept. 24, 545
F	Stela 1, Saccana	10– 2– 5– 0– 0,	9 Ahau	18 Yax Sept. 23, 614

A =1386112, less:

B = 2196 =	3	Venus Rev.	+ 444 days
C = 9858 =	16	" "	+ 515 "
D = 16088 =	27	" "	+ 322 "
E = 44888 =	76	" "	+ 511 "
F = 70088 =	120	" "	+ 18 "

B =1386112, less:

C = 7662 =	13	Venus Rev.	+ 71 days
D = 13892 =	23	" "	+ 462 "
E = 42692 =	73	" "	+ 66 "
F = 67892 =	116	" "	+ 157 "

C =1395970, less:

D = 6230 =	10	Venus Rev.	+ 391 days
E =35030 =	59	" "	+ 579 "
F =60230 =	103	" "	+ 86 "

D =1402200, less:

E = 28800 =	49	Venus Rev.	+ 188 days
F = 54000 =	92	" "	+ 279 "

E =1431000, less:

F =25200 = 43 Venus Rev. + 91 days

F = 1456200

Neither Date A nor Date B can be connected by large intervals of the Venus calendar with a theoretical inaugural setting although the month positions 10 Yax and 16 Yax are close enough to 12 Yax of the formal calendar. Taking out all Venus calendar rounds and eight-year periods between these dates and the inaugural date the remainders are one year less two days and seven years plus two days, implying that the places of Venus were compressed into the circle of the year. Date A is recorded by two other Initial Series at Naranjo besides the one on Stela 24 with the Venus title. It is the day before a solar eclipse syzygy.

Date C on Lintel 29 introduces a calculation which leads up to a final 9-17- 0- 0- 0, 13 Ahau 18 Cumhu, on Lintel 31, this being one of the round number coincidences of Venus. It can be carried back by 19 ordinary calendar rounds to 7- 3-15-17- 0, 8 Oc 13 Yax, June 24, 538 B.C., this being one day in advance of the formal place on 12 Yax. This record is more striking than the two just considered, especially when we note that the actual dates of Venus conjunctions on either side of the recorded date fell on November 16, 448 and June 21, 450, with heliacal risings four days later in each case. Here we have a recapitulation of the original calendar as regards places in the year, close to the ideal construction of Calendar E of our Table XIII. The actual dates of heliacal risings are:

9–13–16–13– 9, 1–11– 2	5 Muluc	16 Zac,	Nov. 20, 448 A.D.
9–13–18– 6–11,	2 Chuen	9 Zotz,	June 25, 450

The formal layout of Calendar E gives: 3 Uayeb, 17 Zac, 11 Zotz, 10 Muan and 4 Mol for such phenomena.

Dates D, E and F are round numbers. The first has 18 Zac of the

Historical Era (Baktun 7) on November 17, which is within a day of a formal Venus position. This date should be compared, I think, to 9-18- 5- 0- 0, 4 Ahau 13 Ceh, Nov. 16, 535, which is found on the splendid Venus Monster monument called the Great Turtle (Altar P) at Quirigua. Here we have 13 Ceh of Baktun 9 combined with November 16, exactly on a place of Venus in the tropical year. In the year 466 of the first date an heliacal rising of Venus took place on June 21, the summer solstice. Now it is an interesting coincidence that in the year 535 of the second date an heliacal rising of Venus took place practically on the vernal equinox. The interval of each date from the era it commemorates can be constructed out of terms of the Venus calendar. Thus:

7– 0– 0– 0– 0, 10 Ahau 18 Zac, Aug. 6, 613 B.C.
2–12–14– 8– 0, 10 rounds of Venus Calendar
9–12–14– 8– 0, 10 Ahau 18 Zac, Nov. 27, 426 A.D.
2– 0–10– 0, 5 short periods of Venus
9–14–15– 0– 0, 11 Ahau 18 Zac, Nov. 17, 466

9– 0– 0– 0– 0, 8 Ahau 13 Ceh, Feb. 10, 176 A.D.
15–16– 6– 0, 3 rounds of Venus Calendar
9–15–16– 6– 0, 8 Ahau 13 Ceh,
2– 8–12– 0, 6 short periods of Venus
9–18– 5– 0– 0, 4 Ahau 13 Ceh, Nov. 16, 535

Date E is the day after the autunmal equinox and also strikes exactly on a solar eclipse syzygy, with the eclipse possibly visible in the northern extremity of the Maya area. The title in the Initial Series of Stela K is the head of the Venus Monster but with the normal device for the planet in the eye. From the Initial Series date a subtraction of 210 days is made which leads back to 1 Oc 18 Kayab on February 25, 545. The actual places of heliacal risings of Venus are October 22, 544 and May 29, 546, 341 days before and 243 after the hotun or 131 days before and 453 after the placement of 1 Oc 18 Kayab. I am inclined to believe the conformity on Venus is limited to the combination of 18 Kayab, a place of Venus in the Maya year and 3 Yax which comes 9 days before 12 Yax and that the purpose may have been to offset the influences of the eclipse by bringing a counter agent.

Date F is just three and a half katuns in advance of E and strikes the autumnal equinox exactly. On Stela 1 at Comitan there is a clear equinoctial glyph, the sun in a half-light, half-dark frame, for the same date. 18 Yax is, of course, only 6 days from 12 Yax, but this does not seem a powerful motive. Perhaps the first historical 1 Ahau regent in Table XV is being referred to: it strikes the autumnal equinox.

This exhausts the list of dates with the normal Venus signs in the introducing glyph but there are numerous other inscriptions with the Venus Monster for title. For instance, 9-15- 0- 0- 0, 4 Ahau 13 Yax, Oct. 22, 471 is nearly always combined with symbolism of the planet,

13 Yax being near 12 Yax. The Initial Series registering the round number coincidences, beginning with 9-14- 0- 0- 0, 6 Ahau 13 Muan, Feb. 4, 452, always have Venus Monster titles. It seems that 3 Zip of 9-16-10- 0- 0, 1 Ahau 3 Zip, May 18, 501, is near enough to 6 Zip of the Venus Calendar to call for the Venus Monster title in the introducing glyph. The same condition obtains where the positions in the tropical year approach any one of the original set beginning with April 12.

There are other cases more interesting in general implications. Take the case of Stela A at Copan. Here the Initial Series reads 9-14-19- 8- 0, 12 Ahau 18 Cumhu, April 5, 471 which coincides exactly with an inferior conjunction of Venus, so that the heliacal rising comes on April 9 and, as it happens, 0 Pop the Maya New-year falls on April 12 of the Venus series. Then there is Stela C, already referred to, which ties in with Stela A by means of the Metonic cycle. It records a date of heliacal rising of Venus and another date far in the past which combines April 12 and 18 Kayab. Here the cyclic interest is unmistakable. Lintel 4 of Piedras Negras gives an heliacal rising of Venus exactly, and moves on to 19 Kayab on April 9, associated with a clear Venus glyph, and then ends with a statement of the Mundane Era.[1] Nearly always when there is obvious Venus symbolism, a real or cyclic phenomenon is at hand. Thus Stela M at Copan has a Venus Monster as title and also a fine altar which represents this grotesque figure. Two tuns then 8 days are clear in the text and although the day and month-signs are absent these numbers added to the Initial Series reach exactly an heliacal setting and rising on

9–16– 7– 0– 0,	13 Ahau	18 Zip,	June 2, 498
8			
9–16– 7– 0– 8,	8 Lamat	6 Zotz,	June 10, 498.

Similarly on Stela 5 at Tikal a clear Venus sign is explained by an eight days and a tun 14, one year after the tun 13 of the Initial Series, which reaches heliacal setting of the planet on 9-15-14- 0- 8, 8 Lamat 11 Yaxkin, Aug. 17, 485 A.D.

Correlation A seems, then, to be justified by the Venus evidence, which joins forces with that on the moon. The protagonists of Correlation B have attempted no structural handling of the Venus material. Teeple in his recent paper frankly evades the issue of Venus. He adds a footnote to his general condemnation of Correlation A for failure to reach his explanation of the Supplementary Series, using these words: "The same remarks apply to Dr. Spinden's *Maya Inscriptions dealing with Venus and the Moon*. . . . If this article is meant to present evidence of his correlation I am quite unable to follow the argument." Actually this criticism reflects on the Mayas for using astronomical data in different psychological associations than the ones to which we ourselves are accustomed.

[1] See Spinden, 1928 a, p. 23.

Solstices, Equinoxes and the Farmer's Year

The cryptic references in the Maya Chronicles to the "setting of Pop in order" acquired a definite and romantic meaning when connected with two 0 Pop dates on Altar U at Copan and another date, namely 6 Caban 10 Mol, prominently displayed on the same monument: the places reached were April 9 for the former and September 2 for the latter which were also found by sunset readings, according to the reported angle, along a line of sight which passed across the valley from Stela 10 to Stela 12. Further study disclosed the fact that the date on one of the monuments marking this astronomical base line corresponded to September 6 and it soon became evident that another pair of readings had been April 5 and September 6, (implying that the angle of the line had been changed), while there were indications that a third pair of dates was April 12 and August 30. The explanation was offered that these sets of positions, one in the spring and one in the fall, were ceremonial times that opened the clearing and planting seasons for two crops of maize. A recent redetermination of the angle of this astronomical base-line proved unexpectedly difficult owing to smoky atmosphere but it seems likely that the sunset readings of the present settings of Stela 10 and Stela 12 may be April 12 and August 30.

The Stations of the Farmer's Year. There were doubtless conditions of an astrological nature to be satisfied as well as those of a purely seasonal nature in matters of the farmer's almanac. Tzolkin patterns for planting and other activities are seen in the Dresden and Tro-Cortesianus codices. We have already noted that April 12 and September 3 were formal places of Venus in the natural year at the inauguration of the ceremonial calendar of this planet (more precisely the heliacal risings were on September 2, 535 B.C. and on April 13, 533 B.C.). August 30, on the other hand coincided with the closing of the half-katun 9-15-10-0- 0, 3 Ahau 3 Mol, Aug. 30, 481. There is reason to believe that round numbers at earlier times also influenced the ceremonial days of the farmer's almanac, for example:

8– 9– 0– 0– 0,	4 Ahau	18 Ceh,	April 9, 41 B.C.
8–16– 0– 0– 0,	3 Ahau	8 Kankin,	April 5, 97 A.D.
9– 1–10– 0– 0,	5 Ahau	3 Tzec,	Sept. 7, 205
9– 5– 0– 0– 0,	11 Ahau	18 Tzec,	Sept. 5, 274
9–12– 0– 0– 0,	10 Ahau	8 Kankin,	Sept. 1, 412
9–15–10– 0– 0,	3 Ahau	3 Mol,	Aug. 30, 481
9–19– 0– 0– 0,	9 Ahau	18 Mol,	Aug. 29, 550

At about the time Pop was being "set in order" 1 Ahau 3 Mol was regent of the Venus Calendar. In 477 the adjustment between 3 Mol and an heliacal rising of the planet was close. Now on Stela A, which has dates interlocking with those on Altar U, the Initial Series reaches an inferior conjunction of Venus on 18 Cumhu and April 5, so that the

first appearance of the planet as morning star was on April 9 while 0 Pop fell, as it happened, on the third date of the series, namely April 12.

To this layout of astronomical and calendarial facts a third element intruded since the moon called for consideration. On Altar U, in the midst of the very year which intervenes between 2 Eb 0 Pop on April 9, 480 and 3 Caban 0 Pop on April 9, 481, is recorded 9 Ik 10 Mol, September 6, 480. This is the date pairing with April 5 and as placed here it coincides with a visible eclipse of the moon.

The reaching of suitable places of the planets was for the astronomical priests of the Mayas a matter of religious as well as scientific judgment. It seems that they wielded a kind of diplomatic obedience to the heavenly signs, doubtless playing one against another in times of supposed need. The congress of astronomers, who debated the date 6 Caban 10 Mol, September 2, 503 A.D., may have decided on the base-line April 12-August 30 instead of April 9-September 2 as the combination of dates would lead us to suppose. An eclipse of the sun, total at high noon at Copan had taken place on J.D. 1900273, which reduces to September 2, 490. Perhaps they considered that this had been too strong an omen against the April 9-September 2 arrangement. By 503 the place of 0 Pop had receded to April 5 and the heliacal risings of Venus at eight year intervals were taking place still earlier.

The so-called observatory at Uaxactun, first pointed out by Blom and carefully investigated by Ricketson, yields the summer and winter solstices by outer lines of sight and April 5 and September 6 by inner lines of sight from the same place of observation. The fact that two of the stelae set up in the court record April 5 as the round number 8-16- 0- 0- 0, 3 Ahau 8 Kankin, Apr. 5, 97 A.D., certainly adds to the probability that the structural group was connected with sunset observations. Another monument at Uaxactun reaches April 12 in the year following the two round numbers on April 5. The Round Tower at Chichen Itza, reputed to have been built by Quetzalcoatl, also gives angles of astronomical significance, as Ricketson has shown.

Displaying Maya Dates Statistically. Teeple makes the plea that coincidences of inscribed dates with solstices, equinoxes and points of the Farmer's Year found by me under Correlation A are by pure chance. He avoids comment on the part that chance would play in combinations of such dates in single inscriptions, on the symbolism of the sculptures carrying the dates and on the hieroglyphs which accompany them. I propose therefore to test his statements and suggestions.

In his article for the Carnegie Institution he writes as follows:

"There are probably over 2,000 separate dates mentioned on Maya monuments which would be an average of 5 or 6 or 7 for each day of the year. So if one starts with any assumed correlation it is fairly easy to find Maya dates which coincide with his ideas of solstices and equinoxes.

It would be just as easy, allowing a day or two leeway to find 20 or 25 dates proving that the Mayas celebrated Washington's Birthday or Yom Kippur. That does not look like a feasible method of producing convincing evidences. We have no real knowledge that the Mayas were interested in equinoxes and solstices any more than they were with the Fourth of July."

The number of legible dates in the Maya inscriptions is less than 1,000 instead of Teeple's presumed 2,000. Indeed I was able to find only 879 reasonably certain dates, more than half of which fell on round numbers. These dates I treated statistically. First I prepared a graph showing the number of times each one of the 365 positions of the Maya year is recorded under the 471 round numbers and the 408 non-round numbers. Secondly I tabulated the positions in the European year reached by applying Correlation A and prepared another graph or profile also subdivided into round numbers and non-round number dates. On this graph the incidence for Correlation B reads off when a new point of departure is made for January 1 some 63 days after the January 1 of Correlation A.

Let us test Teeple's suggestion that Washington's Birthday would be hit by 20 or 25 dates on the Maya inscriptions. Under Correlation A a single Maya date falls in the five day stretch from February 20 to 24, inclusive, and under Correlation B it happens that four out of the five days have one record apiece. Unfortunately Yom Kippur as a movable fast cannot be tested on our graphic tables.

We now turn to a more serious comparison beginning with the incidence of dates of the inscriptions in the Maya year. The round numbers are hotuns and above, the same month place returning in 73 hotuns (18- 5- 0- 0) : thus 13 Ceh of 9- 0- 0- 0- 0 is found again at 9-18- 5- 0- 0.

TABLE XVII

DISTRIBUTION OF DATES OF THE INSCRIPTIONS IN THE MAYA YEAR

Round number positions theoretically possible	73
Round number positions reached by known dates	65
Round number "peaks" of 10 or more	9
Non round number positions possible	365
Non-round number "peaks" of 6 or more	13
Non-round number positions reached but once	92
Non-round number positions not reached	147

The heaviest incidence on round numbers strikes the dates that actually have significance by reason of Venus coincidences or cycle references: namely the heliacal risings found at 9-17- 0- 0- 0, with 20 cases, and at 9-14- 0- 0- 0- with 19. Third and fourth places are divided between 13 Ceh which combines 9- 0- 0- 0- 0 and 9-18- 5- 0- 0 (one being the Era of the Chronicles and the other actually reaching November 15 which has cyclic value in the Venus Calendar) and 13 Yax found at 9-15- 0- 0- 0, which is another cyclic position of Venus. Next come 16 round

numbers on 8 Cumhu of the Mundane Era and 15 on 9-11- 0- 0- 0, which is primarily a lunar round number.

Of places in the Maya year reached by non-round number dates the leading place (9 cases) is held by 10 Mol, one of the month positions of the Copan base line; 18 Kayab of the Venus series has 8 cases as has 6 Kayab, while 12 and 13 Yax are together represented by 10 dates and in combination with 13 Yax as a round number, easily dominate the entire table.

We now pass to places in the European year under Correlation A. This shows very little in common with the preceding table. The round numbers fall in clusters since three and a half katuns are only 1.76 days less than 69 tropical years.

TABLE XVIII

DISTRIBUTION OF DATES OF THE INSCRIPTIONS IN THE EUROPEAN YEAR

Round number positions theoretically possible	365
Round number positions reached by known dates	85
Round number "peaks" of ten or more	10
Non-round number positions possible	365
Non-round number "peaks" of 6 or more	13
Non-round number positions reached but once	103
Non-round number positions not reached	129

For round numbers the same dates lead as before, namely, 9-17- 0- 0- 0, 9-14- 0- 0- 0, 9-15- 0- 0- 0, of interest to Venus and 9-11- 0- 0- 0 to the Moon. As regards non-round numbers, first place is held by September 2 of the base line with 8 hits, and July 3 which corresponds to two dates at Quirigua and Yaxchilan each due to strike the summer solstice on the next calendar round. Next place is held by December 21 of the winter solstice while clear peaks are found on the summer solstice, the autumnal equinox, the vernal and autumnal stations of the Farmer's Year and on a few other places in the tropical year.

Equinoxes and solstices under Correlations A and B, allowing one day on either side of the mean day, find 43 clean hits under Correlation A, usually in emphasized dates, and 21 under Correlation B. Under the latter correlation not a single date reaches the autumnal equinox and only one reaches the winter solstice. The only apparent superiority for Correlation B is in connection with dates which strike the vernal equinox but these same dates have an adequate explanation under Correlation A in connection with eclipses and the round number 9- 6- 0- 0- 0. The tabulation follows. On the other hand two of the vernal equinox dates of Correlation A are reached by Initial Series on Stela 5 at Copan and Stela 6 at Naranjo.

TABLE XIX

COINCIDENCES WITH THE EQUINOXES AND SOLSTICES

	Correlation A Equation 489384		Correlation B Equation 584284	
Vernal Equinox				
March 20	0		5	
March 21	3	4	8	14
March 22	1		1	
Summer Solstice				
June 21	0		1	
June 22	5	10	2	6
June 23	5		3	
Autumnal Equinox				
September 22	0		0	
September 23	8	16	0	0
September 24	8		0	
Winter Solstice				
December 20	3		1	
December 21	7	13	0	1
December 22	3		0	

Anniversaries. The establishment of the Historical Era at Baktun 7 is part and parcel of Correlation A. The era is referred to by a special glyph (see Spinden, 1924, pp. 163-166) found as follows and strongly emphasized by position: Aguas Calientes, Stela 1; Cancuen, Stela 1;

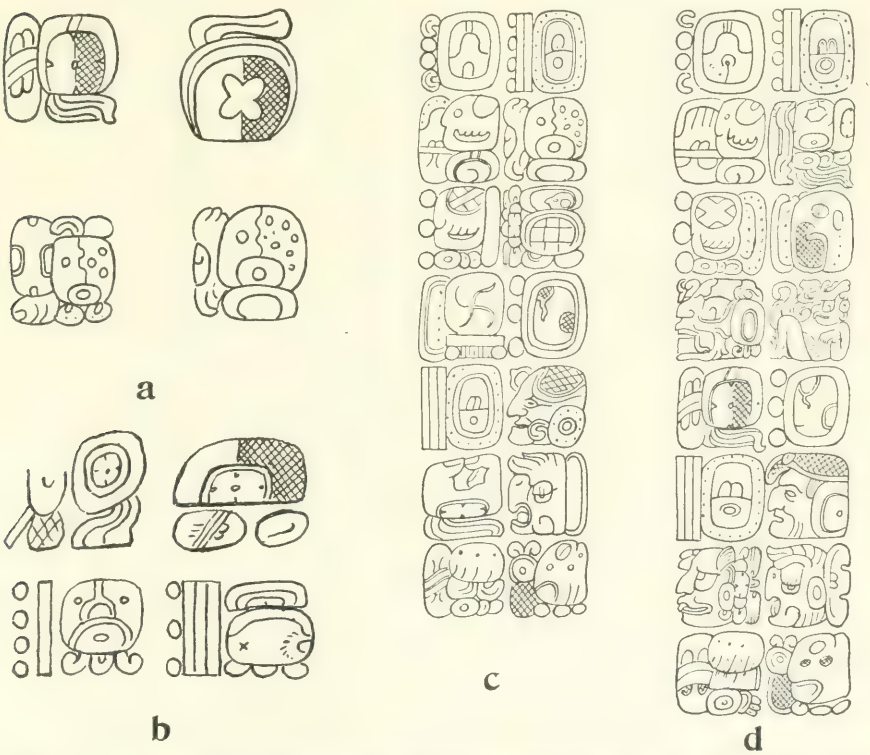


Fig. 14. Glyphs and Dates of the Autumnal Equinox: *a*, half-light, half-dark glyphs; *b*, Stela 1, Comitan; *c* and *d*, Palenque.

Copan, Altar T; and, in opposition to Baktun 9, on Stela D, Copan; Stela 2, Tikal and the Tablet of the Sun, Palenque. Anniversaries of the beginning day of this Historical Era are commonly recorded, both for the tropical year and the Maya year, and very often in combination with dates which reach the solstices or have other chronological significance. The associations make it impossible to manipulate these dates under Correlation B or any other arrangement than Correlation A without sacrificing the apparent significance. I list in Table XX some thirty records which deal with restatement of the Historical Era, and note that in addition the Toltec Era was established by Quetzalcoatl in 1168 on an exact anniversary of this chronological base of the Mayas.

TABLE XX

ANNIVERSARIES OF THE HISTORICAL ERA

7– 0– 0– 0– 0, 10 Ahau 18 Zac, Aug. 6, 613 B.C.

A. Anniversaries in the Tropical Year

Copan, Stela N	9–16–13– 4–15,	6 Men	3 Yaxkin,	Aug. 6,	504	With Dec. 22
El Cayo, Lintel 1	9–16–12– 4–10,	5 Oc	3 Yaxkin,	" 6,	503	With June 23, Sept. 3
Copan, Altar V	9–18–17–16– 6,	9 Cimi	14 Yaxkin,	" 5,	548	With Sept. 2
Yaxchilan, St. 12	9–18– 3–12–15,	6 Ix	12 Yaxkin,	" 7,	533	With June 22
Palenque, T. of C	9– 3– 6– 7–17,	5 Caban	0 Zotz,	" 6,	241	
" T. of S	9–10– 8– 9– 3,	9 Akbal	6 Xul,	" 6,	433	(?)
Quirigua, St. D	9–16–13– 4–17,	8 Caban	5 Yaxkin,	" 7,	504	
Naranjo, St. 8	9–18– 9–14– 3,	11 Akbal	11 Yaxkin,	" 4,	540	With 10 Ahau, 18 Zac.
" St. 13	9–17–15–13–10,	2 Oc	8 Yaxkin,	" 5,	526	
Loltun Cave	12– 1– 0– 0– 0,	3 Ahau	18 Kayab,	" 8,	1378	(?)
Tulum St. 2	12– 8– 0– 0– 0,	2 Ahau	3 Pop,	" 5,	1516	(?)

* * *

9– 8–15– 0– 0, 10 Ahau 8 Tzec, Aug. 8, 348

Copan, St. 4 (with 18 Zac, Nov. 17); Piedras Negras, St. 39

* * *

9–12– 5– 0– 0, 3 Ahau 3 Xul, " 6, 417

Copan, St. 1, Altar; Piedras Negras, St. 39; Yaxchilan, Stela 1, Altar; Quirigua, Stelae A and C (5 katuns subtracted from 9–17– 5– 0– 0)

* * *

9–15–15– 0– 0, 9 Ahau 18 Xul, Aug. 4, 486

Quirigua, Stela S, I. S.; Seibal, Hieroglyphic Stairway; Tonina, Stela 1; Yaxchilan, Stela 11 (with 9–15–19– 1– 1, 1 Imix 19 Xul, Aug. 4, 490 a cyclic date of Venus Calendar).

B. Anniversaries in the Maya Year

Quirigua, Altar M 9–15– 3– 2– 0, 6 Ahau 18 Zac, Nov. 15, 474 Venus date 9–19– 0– 3–0, 4 Ahau 18 Zac, Oct. 28, 550

Naranjo, Stela 7 (with 10 Ahau, Aug. 4); Naranjo, Stela 10.

* * *

9–14–15– 0– 0, 11 Ahau 18 Zac, Nov. 17, 466 Venus date

Copan, Stela 4; Temple 11, doorway (with Sept. 2, etc.); Hieroglyphic Stairway; 9–19– 0– 3–0, 4 Ahan 18 Zac, Oct. 28, 550

Naranjo, Stela 18, I. S. (Venus title); Piedras Negras, Stela 23.

Anniversaries of the Mundane Era, namely October 14 and 8 Cumhu are recorded in coincidence with eclipses and in combination with solstices, etc. They are pretty clearly intended in dates at Chichen Itza and Uxmal.

Complexes. Into groups of a few dates, explained for them by hieroglyphs, the Mayas compressed the gist of calculations by a kind of epigraphic mathematics. They dealt mostly with astronomical controls over human destiny, as they thought. Eclipses and heliacal risings only received inscriptional treatment when occurring in strategic relationships with other matters, such as round numbers, solsticial and equinoctial points of the year, the anniversaries of eras, etc. For other times the cyclic dates of Venus and the moon may have had greater significance than real dates.

Six dates on Stela C at Copan furnish an heliacal rising on a round number, a visible eclipse of the sun on the anniversary of the Mundane Era, a combination of 18 Kayab and April 12, both sacred dates of Venus, located in the distant past, and a skilful use of the Metonic cycle between other dates. Temple 11 at Copan, which has Stela N and the Reviewing Stand as part of its structural complex, boasts in all only nine dates. These strike an heliacal rising of Venus on another round number than that of Stela C, September 2 of the base line, 8 Cumhu of the Mundane Era, both August 6 and 18 Zac of the Historical Era, the winter solstice on a round number in the past, while other significant dates are missed by only a day or two. More than twenty other monuments of the Mayas show similar combinations of three or more astronomical elements.

Conclusion. In closing I wish to summarize the arguments which support Correlation A as the correct key to Maya chronology. Under this correlation the Venus and Lunar Calendars of the Dresden Codex are revealed as marvelous machines for the handling of phenomena over vast stretches of time. Places are found where recorded patterns of these calendars function exactly but without disturbing the cyclic features of the basic uncorrected calendars. Dates in connection with these famous tables which have long been stumbling blocks, are shown to have cyclic significances. This is especially notable in the case of cyclic eclipse positions at 9-16- 4-10- 8, 12 Lamat 1 Muan, etc., as explained by Ludendorff. This astronomer also eliminates the Supplementary Series as an obstacle to Correlation A and converts it into a confirmation.

Consequently we now conclude that while the formal day count of the Mayas began on August 6, 613 B.C., they did have a record of intervals between eclipses extending back at least as early as 752 B.C. Analysis of between eight and nine hundred dates on the monuments of the First Empire, discloses about fifty references to true places of Venus, besides a very large number of cyclic places, about fifty dates on the solstices

and equinoxes, about forty direct or anniversary statements of the Historical Era, about thirty direct or anniversary statements of the Mundane Era; 23 dates on the three vernal stations of the Farmer's Year and 55 dates on the three autumnal stations. As regards eclipses, a considerable number of dates, over twenty at least, strike eclipse syzygies. These include five visible eclipses of the moon and one, perhaps more, of the sun. Also there are ten or more cases where an eclipse comes four days after the record showing that the cyclic moon was put down in place of the real one.

The Maya record of inscriptions is therefore highly astronomical. So much appears from our present knowledge, even though Jupiter, Saturn, Mars and Mercury are unexplained possibilities. But we need not assume that all the inscribed dates have an astronomical meaning. Some events of a political nature may also have been deemed worthy of record.

Bibliography

AVENDAÑO (See Means)

BEUCHAT, H.
1912. Manuel d'archéologie Américaine. Paris.

BLOM, F., AND LA FARGE, O. G.
1926-27. Tribes and temples. 2 vols. New Orleans.

BOOK OF CHILAM BALAM OF CHUMAYEL
1913. Facsimile. Univ. of Penn. Anth. Pub. V.

BOOKS OF CHILAM BALAM, CHUMAYEL KAUA, TIZAMIN, ETC.
Photographic reproduction by Gates in Bowditch collection. Peabody Mus. Harvard Univ.

BOWDITCH, C. P.
1901. Memoranda on the Maya calendars used in the Books of Chilam Balam. Am. Anth. N.S. III, pp. 129-138.
1906. The Temples of the Cross, of the Foliated Cross and of the Sun at Palenque. Cambridge.
1909. The dates and numbers on pages 24 and 46 to 50 of the Dresden Codex. Putnam anniversary volume, pp. 268-298. New York.
1910. The numeration, calendar system and astronomical knowledge of the Mayas. Cambridge.

BRASSEUR DE BOURBOURG, C. E.
1857-59. Histoire des nations civilisées du Mexique et de l'Amerique-centrale durant les siècles antérieurs à Christophe Colomb. 4 vols. Paris.

BRINTON, D. G.
1882. The Maya chronicles. Philadelphia.
1885. The annals of the Cakchiquels. Philadelphia.
1893. The native calendar of Central America. Proc. Am. Phil. Soc., XXXI, pp. 258-314.

BULLETIN 28
1904. Mexican and Central American antiquities. (24 translations of German papers.) Bulletin 28. Bur. Am. Ethnol. Washington.

CALENDARIOS
1685. Calendario de los Indios de Guatemala, Cakchiquel. M.S.
1722. Calendario de los Indios de Guatemala, Quiché. M.S.

COGOLLUDO, D. LOPEZ DE
1688. Historia de Yucathan. Madrid.

FOERSTEMANN, E.
1880. Die Maya-Handschrift der Königlichen Bibliothek zu Dresden.
1887-1898. Zur Entzifferung der Mayahandschriften I-VII. Trans. in Bull. 28.
1901. Commentar zur Mayahandschrift der Königlichen öffentlichen Bibliothek zu Dresden. Dresden. Tran. in Peabody Mus. Pap., IV, No. 2.

GOODMAN, J. T.
1897. The archiac Maya inscriptions. In Biologia Centrali-Americana, archeology, appendix. London.
1905. Maya dates. Am. Anth. N.S., VII, pp. 642-647.

GUTHE, C. E.
1920. A possible solution of the number series on pages 51 to 58 of the Dresden Codex. Peabody Mus. Pap., VI, No. 2. Cambridge.

JOYCE, T. A.
1914. Mexican Archeology. New York.

LANDA, D. DE
1864. Relation des choses de Yucatan. Paris.

LIZANA, B. DE
1893. Historia de Yucatan. (Original edition, Valladolid, 1633.) Mexico.

LONG, R. C. E.
1918. The Maya and Christian eras. Man., 1918, No. 70.
1924. The age of the Maya calendar. Jour. Roy. Anth. Inst. Gt. B. and Ireland, LIV, pp. 353-362.

LOTHROP, S. K.
1930. A modern survival of the ancient Maya calendar. Internal. Cong. of Amer. 23rd Session, New York, 1928.

LUDENDORFF, H.
1930 a. Ueber die Entstehung der Tzolkin-Periode im Kalendar der Maya. Preussischen Akad. der Wissensch., Phys.-Math. Classe. Berlin.
1930 b. Ueber die Reduktion der Maya-Datierungen auf unsere Zeitrechnung. idem.

MAUDSLAY, A. P.
1889-1902. Archeology. In Biologia Centrali-Americana. 4 vol. London.

MEANS, P. A.
1917. History of the Spanish Conquest of Yucatan. Peabody Mus. Pap., VII. Cambridge.

MARTINEZ HERNANDEZ, J.
1910. Los grandes ciclos de la historia Maya segun el manuscrito de Chumayel. Merida, Yuc.
1926. Cronica de Yaxkukul. Merida, Yuc.
1928. Significacion cronologica de los ciclos Mayas. Merida, Yuc.

MEDIZ BOLIO, A.
1930. El libro de Chilam Balam de Chumayel, traduccion del idioma Maya al castellano. San Jose, Costa Rica.

MEINHAUSEN, M.
1913. Ueber Sonnen- und Mondfinsternisse in der Dresden Mayahandschrift, Zeit. f. Ethnol., XLV, pp. 221-227.

MORLEY, S. G.
1910. The correlation of Maya and Christian chronology. Am. Jour. Arch., 2nd S., XIV, pp. 193-204.
1911. The historical value of the Books of Chilam Balam. Am. Jour. Arch., 2nd S., XV, pp. 195-214.
1916. The supplementary series in the Maya inscriptions. Holmes anniversary volume, pp. 366-396. Washington.
1917. The hotun as the principal chronological unit of the Maya empire. 19th Internat. Cong. of Amer. (1915), pp. 195-201. Washington.
1920. The inscriptions at Copan. Carnegie Inst. of Wash., Pub. No. 219. Washington.
1914-1929. Archeology. In yearbooks, Carnegie Inst. of Wash. Washington.

NEUGEBAUER, P. V.
1929. Astronomische chronologie. 2 vols. Berlin.

OPPOLZER, TH. VON
1887. Canon der Finsternisse. Denschriften Kaiserl. Akad. Wissensch. Math-Naturw., Classe, LII, Wien.

PALACIOS, E. J.
1928. En los confines de la selva Lacandon, Mexico.

PEREZ, J. PIO
1843 a. Ancient chronology of Yucatan, or a true exposition of the method used by the Indians for computing time. In Stephens, J. L., Incidents of travel in Yucatan, Vol. I, Appendix.
1843 b. A manuscript written in the Maya language, treating of the principal epochs of the history of the Peninsula of Yucatan before the conquest. idem, Vol. II, Appendix.

RELACIONES DE YUCATAN
1898-1900. Relaciones historico-geograficas de las provincias de Yucatan. 2 vol. Madrid.

RICKETSON, O. G., JR.
1924-30. Field reports. In year-books. Carnegie Inst. of Wash., Washington.

ROYS, R.
1922. A new Maya historical narrative. Am. Anth. N. S. XXIV, pp. 44-60.

SANCHEZ DE AGUILAR, P.
1639. Informe contra idolorum cultores del Obispado de Yucatan. Madrid.

SCHRAM, R.
1908. Kalendariographische und Chronologische Tafeln. Leipzig.

SELER, E.
1895, a. Die wirkliche Länge des Katun's der Maya-Chroniken und der Jahresanfang in der Dresdener Handschrift und auf den Copan-Stelen. Zeit. f. Ethnol. XXVII, Verhand, pp. 441-449.
1895, b. Bedeutung des Maya Kalenders für die historische Chronologie. Globus, LXVIII, pp. 37-41.
1902-23. Gesam. Abh. 5 vols. Berlin.

SPINDEN, H. J.

1910. Table showing the chronological sequence of the principal monuments of Copan. Am. Mus. Nat. Hist., New York.

1913. Maya Art. Peabody Mus., Mem. VI. Cambridge.

1920. Central American calendars and the Gregorian day. Proc. Nat. Acad. of Sci. VI, pp. 56-59.

1924. The Reduction of Maya Dates. Peabody Mus., Pap. VI, No. 4. Cambridge.

1928, a. Maya inscriptions dealing with Venus and the Moon. Bull. Buffalo Soc. Nat. Sci., XIV, No. 1, Buffalo.

1928, b. Ancient civilizations of Mexico and Central America, 3rd ed. Amer. Mus. Nat. Hist., New York.

TEEPLE, J. E.

1925, a. Maya inscriptions: glyphs C, D, and E of the supplementary series. Am. Anth. N.S. XXVII, pp. 105-115.

1925, b. Maya inscriptions, further notes on the supplementary series. idem, XXVII, pp. 544-549.

1927, a. Maya inscriptions: the Venus calendar and another correlation. idem. XXIX, pp. 278*-282*.

1927, b. Maya inscriptions, IV, idem. pp. 283*-291*.

1930. Maya astronomy. Carnegie Inst. of Wash. Pub. No. 403, pp. 29-115.

THOMAS, C.

1882. A study of the manuscript Troano. Cont. N. A. Ethnol, V. Washington.

1900-04. Mayan calendar systems. 19th Rep. Bur. Am. Ethnol., pp. 693-819; 22nd Rep., pp. 197-305.

THOMPSON, J. E.

1927. A correlation of the Mayan and European calendars. Field Mus. Pub. 241.

TOZZER, A. M.

1927. Time and American archæology. Nat. Hist. XXVII, pp. 210-222.

VALENTINI, P. J. J.

1879. The katunes of Maya history. Proc. Am. Antiq. Soc., No. 74, pp. 71-117.

VILLAGUTIERRE SOTO-MAJOR, J. DE

1701. Historia de la conquista de la provincia de el Itza. Madrid.

WILLSON, R. W.

1924. Astronomical dates in the Dresden Codex. Peabody Mus. Pap. IV, No. 3. Cambridge.

N. D., a. Dates of the inferior conjunctions of Venus. M.S. Peabody Mus.

N. D., b. List of visible eclipses of the sun. M.S. Peabody Mus.